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The Colliery Engineer
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Modern Coal-Boat Unloading

Apparatus In Use on the Great Lakes for Handling Coal from Vessels' Holds to Cars or Stock Piles

By J. F. Springer

THE problem of unloading coal from ships and barges is quite different from loading coal into vessels. At Fort William, Ontario, the Canadian Pacific Railroad is operating a new plant which is dealing with coal in a vessel's hold in larger units than have hitherto been employed. The Hulett unloader has been used in taking out iron ore from Great Lake vessels for a number of years with great success. The present installation at Fort William is, however, the first instance where this apparatus has been applied to unloading coal. At this plant each of the two machines in service has a capacity of 8 tons per operation, and in one hour, under ordinary favorable conditions, both together are able to unload 500 tons, or at this rate a 6,000-ton vessel can be released in 11 or 12 hours after actual unloading begins. These are probably the best results so far attained with any single piece of unloading apparatus. At Fort William, the two unloading units can be put simultaneously to work. The capacity of the plant is then

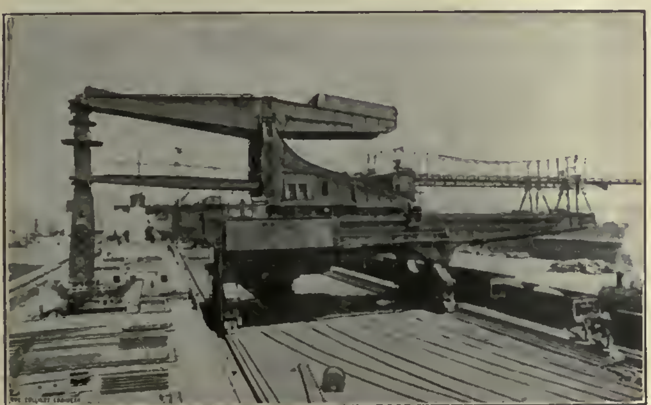

FIG. 1. HULETT COAL UNLOADER

FIG. 2. UNLOADER AND TRESTLE

FIG. 3. REHANDLING AND STOCK-PILING BRIDGE AT FORT WILLIAM, ONT.

perhaps in excess of any other in the world. Two hundred carloads, of 40 to 45 tons each, per day of 10 hours is the capacity of a very respectable loading pier.

The Hulett unloader has two members similar to the halves of a clam-shell grab bucket; these seize and close upon the coal in the hold. However, the arrangements above

Fig. 4. Coal Handling Bridges at Superior, Wis. Water End

the "bucket" are very different from what they are in ordinary grab-bucket practice. There is a large and stiff vertical tube, Figs. 1 and 2, above the bucket pieces, in which an operator is located. This man is able to control the place and extent of the grabbing operation. In iron ore practice it has been found possible to clean up the hold to the extent of 97 per cent. of the load.

At Fort William coal comes in by water and leaves by land. The actual water frontage of the dock is 600 feet; but this is sufficient to accommodate the largest of the lake coal boats. Along the edge of the dock there is a double track for the accommodation of railway cars waiting for their loads. Thirty cars, 15 on either track, may be in waiting here. Overhead is a trestle which extends in single-track form for perhaps 1,200 feet along the side of a space devoted to the stock pile. Larry cars are operated on the trestle tracks. They receive coal from the Hulett unloaders and deliver it either to pockets or bins arranged over the positions which the waiting road cars occupy or else to the stock pile. The steel pockets have a capacity of 40 tons each and are 30 in number. They empty into movable chutes which discharge directly into the cars if they are open ones. If box cars are in waiting, a special type of apparatus is employed to transfer the coal into them. If the larry cars are not to deliver their contents to railway cars at the time of unloading the vessel, they proceed out on to the single-track trestle which runs along one border of the stock pile. There is a big bridge whose broad track runs along parallel with the trestlework covering the 1,200 feet before mentioned and the space alongside the double-track trestle. In fact, the bridge runway has a total length of something over half a mile. This bridge, 475 feet in length, overhangs its track on either side. The rails are 285 feet apart, and the bridge cantilever extensions are 100 and 90 feet, respectively. The longer arm, when the bridge is alongside the railway-car station, overhangs the double-track trestle. This bridge may be used to load the cars when coal is to be taken from the storage pile. It is supported, on the trestle end, by a framework of V shape. At the other end, the support is a shear leg. These two supports, or towers, are in turn supported by suitable wheel trucks. The motion of the tower along its runway may be at a rate as high as 75 feet per minute. The lower part of the truss arrangement is provided with a track running lengthwise of the

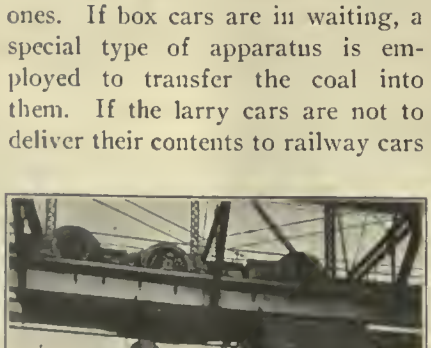

Fig. 5. Grab Bucket and Operating Cab

bridge. A trolley bucket operates on the track at a maximum speed of about 800 feet per minute. The bucket may be hoisted at the rate of about 175 feet per minute. The truss work is high enough to enable the bridge to clear a stock pile 40 feet in height. The bucket is a two-part excavating bucket, having a capacity of about 9 tons. It was thought that the bridge should have a maximum handling capacity of about 600 tons per hour. Everything is electrically operated, the operator being located in a cab on the trolley.

The unloaders have their runway just as is the case with the bridge. The total length of the track is 1,985 feet. This arrangement permits the unloaders to be independently shifted along the water face of the dock or to be moved out of the way. The unloaders are carried on a long base which in turn is supported by wheels on the runway track. There is a carriage which may be shifted lengthwise of this base, that is, transversely to the runway. This carriage supports the walking beam by whose see-saw motion the vertical tube which carries the unloading bucket is raised and lowered. The vertical leg is pivoted at one end of the beam; at the other is an operating cab where an operator is stationed who controls the movements of the walking beam. The arrangements are such that the hanging leg is always vertical and that this leg may be rotated on a vertical axis. This last movement permits the operator to manage the bucket in accordance with varying requirements as seen by him in the hold of the vessel. Further, the halves of the buckets may be variously extended to meet varying conditions of the diminishing coal pile in the boat.

In addition to the Hulett unloader there are several others, for instance the immense grab bucket shown in Fig. 5, which has a capacity of 10 tons and hangs from a trolley truck running on probably the largest coal handling bridge in the world, as the span is 551 feet between towers and it has a length over all of 710 feet. The operator's cab to the right is arranged to travel with the bucket, so that he can place the bucket exactly where he wishes, both when loading and discharging. As transportation by water costs much less than by rail it is customary in summer for the anthracite mines of Pennsylvania to send large shipments by rail to Buffalo, and at that port to transfer the coal to lake steamers which carry it to northern lake ports. In Figs. 4 and 6 are shown the Philadelphia & Reading Coal and Iron Co.'s two coal handling bridges, at Superior, Wis. Each span of these bridges is 237½ feet, but the bridges can be lengthened by means of a gantry and track which is shown raised on the bridge to the left and lowered on the bridge to the right. The trolley bucket has a capacity of 6 tons and is worked by an operator in the moving cab. Both bridges are arranged so that coal from the ships may be loaded into cars or stocked in piles. The bridges being movable the various sizes of coal can be piled separately, but before the coal is loaded from the stock piles into cars it is screened because of the degradation which occurs in handling. In the foreground, Fig. 6, is shown a pile of fine coal which has accumulated during the course of time.

Fig. 6. Coal Handling Bridge, Superior, Wis. Land End

When navigation is open on the Great Lakes the iron and copper mines of Michigan receive sufficient coal at the nearest lake ports to carry them through the winter and until navigation opens in the following spring. The smaller concerns

Fig. 7. Movable Tower, Island Creek Coal Dock, Duluth, Minn.

and inhabitants of cities cannot store coal in this manner, for which reason large coal companies in West Virginia and Pennsylvania store coal during the summer which they deal out in the winter. Figs. 7 and 8 show the two 6-ton trolley bridges of the Island Creek Coal Dock Co., at Duluth, Minn. These have towers at each end which rest on tracks along which they are propelled by their own machinery at the rate of from 50 to 70 feet per minute. Usually cars can be loaded at either end of the bridge, the towers being supplied with hoppers so that the coal can be chuted into the cars and their loading controlled irrespective of the bucket. This arrangement saves considerable spilling of coal by overtopping cars with the bucket loads, and thus avoids the extra labor of cleaning up tracks. In Fig. 8 to the right the hull braces of one of the lake steamers are shown. These braces are covered over when the ship is loaded and form the deck. Such boats have a carrying capacity of from 4,000 to 10,000 tons of freight. They usually go north with coal freight and return with iron ore or grain. Heyl & Patterson, Pittsburg, Pa., constructed the Philadelphia & Reading Coal and Iron Co.'s and the North Western Fuel Co.'s bridges at Superior, Wis., also the C. Reiss Coal Co.'s at Manitowoc, Wis., and the Island Creek bridges at Duluth, Minn.

The relative importance of the various cities in the eastern part of the United States as seaports is in the order named: New York, Galveston, New Orleans, Boston, Philadelphia, and Baltimore. It would appear from this list that Galveston and New Orleans should load more bunker coal than Boston, Philadelphia or Baltimore, and that coal operators should cultivate this trade.

Centralia Mining School Commencement

On June 19, the Lehigh Valley Coal Co.'s school at Centralia held its closing exercises. The program consisted of music, speeches, and awarding prizes. Mr. George R. Wood, instructor, read the annual report of the school which had 137 sessions. The instructors are thoroughly in earnest, as may be judged from their offering two prizes for the best attendance. The first prize was won by Francis Yost, who attended 127 out of the 137 sessions. He is taking a mechanical course. The second prize was given to James Burns, who attended 94 out of 96 sessions. Mr. Burns is taking the mining course.

The school at Centralia has been so successful and has aroused so much enthusiasm that Edward J. Flynn, a former employe of the company, volunteered to give a gold medal to the pupil making the highest average. This was won by J. F. Rowan, a student in mapping and surveying.

The addresses were made by Alexander H. Tiley, of Ashland; Edward Williams, of Centralia; E. B. Wilson, of Scranton. Superintendent H. J. Heffner presided, and B. S. Daddow, assistant superintendent, delivered the prizes.

Fig. 8. Island Creek Coal Dock, Duluth, Minn.

Mine Roof Supports

And Possible Substitutes for the Ordinary Wood Props—Various Forms of Rock and Masonry Pillars and Steel Supports

*By H. I. Smith**

THE natural support for the stratum overlying a coal bed is the coal itself. When the coal has been removed, it has been the practice to use wooden props to support the roof. Pillars of coal take most of the weight and the wooden supports

FIG. 1. TIMBER THAT HAS STOOD 25 YEARS

only keep that portion of the rock directly over them from bulging downwards and falling. In many places it is the practice to leave pillars of coal as the permanent support to the roof strata. However, due to the economic values of these supports, it is the practice in many districts to remove these pillars so far as possible.

Until recent years, no form of mine support has been in general use except wood which could be obtained on the hills in close proximity to the mine opening. The operators could often purchase posts delivered at prices below what it would cost to employ labor to cut the timber on their own ground, and pay the cost of transportation, which was nominal, thus making wood the cheapest material available. From a practical standpoint, wood may be cut to fit varying conditions in the mine without other than ordinary labor equipped with a saw or hand ax. The wood could be obtained sufficiently strong for the purpose for which it was required, and when loaded beyond its capacity it would usually give warning of its rupture by cracking noises in plenty of time to allow the workmen to escape with their tools. These conditions, however, have been passing by degrees, so that few operators are able to send their timbermen to the woods surrounding their mine openings for props, and no longer can they select a certain kind of wood or obtain the class of posts that they formerly used except at high prices.

The problems confronting the mining man today in regard to the increase in the cost of mining operations due to the increasing cost of timber require considerable thought.

The mining engineer is trying to solve the timber problem in the following five ways:

1. Reforestation.
2. Reducing loss by decay.
3. Timber economy in mines.
4. Adopting methods of mining which reduce the timber consumption for maximum recovery of coal.
5. Substitutes for wood.

1. *Reforestation.*—To appreciate what is being done in this line, I have taken some figures from the address of Henry Dinker, President of the American Forestry Association as printed in the *American Forester*, March, 1912.

The state of Pennsylvania has a State Department of Forestry and the second largest State Forest Reserve in the United States (about 1,000,000 acres), with provisions for

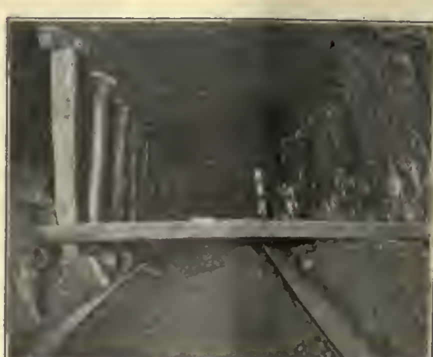

FIG. 2. A FIRM ROOF

purchase of land not exceeding $5 per acre. There are a college and an academy in Pennsylvania giving courses in forestry.

H. S. Graves, the United States Forester, gives full information of the work done by the United States Forest Service in his report of 1912.

FIG. 3. BAD TIMBERING

The report states that among the private interests engaged in the practice of forestry in 1911, were 10 coal companies with acreage distributed as follows: Ohio, 34,510 acres; Indiana, 100 acres; New York, 10,000 acres; and Pennsylvania, 43,308 acres; a total of 87,918 acres. Another company having both coal and railroad interests has 100,000 acres in addition to above; this has no doubt been increased in the last 3 years.*

2. *Reducing Loss by Decay.*—The Department of Agriculture states that 45 per cent. of the timber which is taken into the mines decays, and to reduce this large percentage several methods have been adopted; the most simple being the peeling of the timber and using judgment when the timber is to be cut. Timber cut during the summer months decays more rapidly than that cut during the winter. Loblolly pine cut during the summer has been observed to show the first evidence of decay within 6 to 8 weeks.† Timber after reaching the mine has been given the brush treatment with whitewash,

*Abstract from a paper read at Monongahela meeting of the Coal Mining Institute of America, June, 1914.

*The St. Bernard Mining Co. and Stearns Coal and Lumber Co. also have forestry reserves in Kentucky. See "Forestry Related to Mining," by F. D. Rash, C. E., Vol. 33, p. 511.

†Pennsylvania Mine Inspector's Report, 1912, Part I, p. 20.

cheap paint, creosote, or carbolineum, with effective results. Timber has also been treated with creosote and zinc chloride at a cost of

FIG. 4. ROCK PILLAR

20 and 12 per cent. increase, respectively. Several large coal mining companies have found it necessary to instal plants for the treatment of timber for use in mines.* Treated timber would be in more general use if such wood could be more readily bought in the open market, thus eliminating the cost necessary for individual plants. The preserved timber could be used to advantage where permanent timbers are desired or where timber is to be left standing for 1 year. If treated by one of the above methods this may be considered as the life of timber in any except the best of atmospheric conditions. This life may seem rather short but one would seldom reuse a timber after its being in use 1 year underground. The timber may still look strong but it has lost a great deal of its vitality.

Fig. 1 shows timber that has stood for 25 years. These appeared to be in excellent state of preservation, not a single prop had fallen, but upon careful examination it was found that a penknife could be buried to the hilt with little pressure. These props had been split from the center of white oak trees and contained little or no sap wood. Manifestly there was no weight on these timbers, the roof being supported by the adjacent pillars.

The use of mine timber preserved with creosote or other oils has frequently been condemned on the ground that they increase the inflammability* of the wood; again in case of fire the irritating effect of the smoke is very great. Some European experimenters claim that only a few drops, when burned in a room, will make respiration impossible. However, I am advised by the superintendent of a preservation plant of one of the railroads that after treated timber has stood for 2 or 3 months, it becomes difficult to ignite.

3. *Timber Economy in Mines.* This may be attempted (1) By the use of a portable saw mill to utilize broken or otherwise worthless timber. (2) By dressing the timber.

(1) Portable saw mills have been installed by mining companies for purpose of sawing up broken timbers and odd lengths into caps, lag-

FIG. 5. MASONRY PILLAR

ging, and even lumber. One company using a portable saw mill reported a large reduction in cost of wood. If one company makes a report of this nature, the amount of broken timber and odd lengths being covered up daily in the many mines of our country is a very appreciable item.

In large mines, the saw mill may be underground so that the timber can be cut inside the mine, thus avoiding the necessity of hauling the lumber out of the mine and then back in again.

(2) Dressing timber. Decrease in the cost of timber may be accomplished by removing the bark as soon as cut and allowing the timber to air dry, an operation that will afford the timber a better opportunity to season, add strength, and retard decay. The Department of Agriculture reports that slabbing a prop tends to increase its unit strength, probably the effect of improving its straightness; however, the freight on dressed timber is more than on undressed. Conclusive results could be obtained only by comparing materials cut in the same area. The unit strength of a round post is more than that of a split post of the same area; likewise, the unit strength of round timbers used for beams is less than when a beam is sawed to the same area but proportioned in height to breadth to give the best unit strength design.

Under favorable conditions of roof and floor, props may be made more serviceable by sharpening one end to the form of a wedge or to a point so that the prop will yield somewhat before the elastic limit has been reached.* The results of some tests published by Emil Stens, in *Glückauf*, April 29, 1911, are in

TABLE 1

	Pressure in Tons	Compression Per Cent.
1. Props fastened at upper and lower end........	15.1	.31
2. Prop with a 4-inch wedge-shaped cap on top....	16.3	5.20
3. Props with 4-inch wedge on both ends.........	14.1	8.70
4. Prop with a 4-inch wedge-shaped cap on top and beveled at bottom; length of bevel 1.5 times the diameter...	16.8	17.50
5. Same with bevel 3 times the diameter.........	15.3	18.20

Table 1. The props consisted of straight pine 10 centimeters (3.94

FIG. 6. CONCRETE MINE PORTALS

inches) in diameter and 1.4 meters (or 55.12 inches) long. Five props were used for each test.

*MINES AND MINERALS, Vol. 30, pp. 93, 435; Vol. 32, p. 706; Vol. 33, p. 32.

*MINES AND MINERALS, Vol. 30, p. 428.

*This probably refers to longwall mining.—EDITOR.

The results of these tests show that the yielding capacity of props can be increased from .3 per cent. to 18.2 per cent. without decreasing the carrying capacity of the timber. On account of the varying grain in the wood, it is always best to toe the bottom of the prop into the ground by 1 or 2 inches. The best results are obtained by using a cap piece with some sap wood. This being soft, allows the prop to adjust itself so that the pressures come on it more evenly.

W. H. Hepplewhite, who was among the first to try out the pointed or tapered prop, conducted a test on props 6 feet long and 6 inches in diameter with a 15-inch taper. At 15 tons, the prop began to broom at the bottom and at a pressure of 34 tons the prop began to buckle in the middle. This allowed a roof depression of 15 inches without damage to the bulk of the prop whereas a prop with square ends would have broken and become useless when the roof had come down about 2 inches. The former prop could have been redrawn and reset, the latter could not. Men using axes to cut their props instead of sawing, can taper a prop within 1 or 2 minutes of the same time that is required to cut off an end.

The use of pointed props for gob timbers is worth considering where the floor is medium hard, especially in places where the roof is firm. A roof of this kind is shown in Fig. 2. This same effect is produced in a minor way by placing the wooden prop on a pile of soft dirt, but this does not seem so practicable since the compression at first is very rapid at low pressure and then quickly changes to a very slow rate of compression.


Fig. 7. After an Explosion

J. P. Houfton, President of the Institution of Mining Engineers, page 196, Vol. 43, of the Transactions, gives the following interesting instance.

He drew a comparison between steel and tapered props. He happened to have one colliery where they were using nothing but tapered timber props, and another colliery where steel props were exclusively in use. At the former colliery, the cost of timber was from 6 to 7 cents per ton of coal produced, and at the colliery where steel props were in use, the cost of the props—after allowing 25 per cent. for depreciation—came to a very minute fraction over 2 cents per ton. In the mine where the tapered props were used, he could not remember of a single fatal accident having occurred. Over 2¼ million tons of coal had been brought out without a life being lost at the coal face, and that, he thought, might perhaps be attributed largely to the fact that tapered props were used. Fig. 3 shows an ideal place for the use of pointed or yielding props.*

*And an ideal example of poor timbering.—Editor.

4. *Adopting Methods of Mining Which Reduce the Timber Consumption for Maximum Recovery of Coal.* The timbering problem is so closely related to mining methods that this phase must be considered sooner or later. In the room-and-pillar method often no attempt is made to recover timber; with the longwall method a large part of the timber is sometimes recovered. In hydraulic filling, the first excavations are filled or partly filled with loose material, which in time acts as a roof support while the pillars of coal are being removed. This method will support the roof and stop squeezes where all other known methods have failed. The writer has observed pillars being extracted with the use of very little timber where a squeeze heaved the bottom of the old entry up tight against the roof and almost entirely supported the roof while the coal was being removed.


Fig. 8. Pack Wall

5. *Substitutes for Wood.*—I wish to call attention to what has been done in securing substitutes for timber.

Hydraulic filling has been a valuable means for recovering pillar coal and preventing annoying surface movements. The use of hydraulic filling is such a large topic that I shall but call it to your attention.

Another substitute for wood is hand stowing of waste materials from the mine along the main passages, in the working places and as pack walls in longwall work, see

Fig. 8, showing a pack wall in an Illinois mine.*

A third substitute is the building of rock pillars without the use of cementing material. Fig. 4 is such a pillar and when compressed about 30 per cent. has a resistance to load about equal to what coal will stand in the pillar. A pillar of this kind is serviceable and costs about $1.25 per cubic yard for construction.

A fourth substitute is the use of well-constructed concrete, brick, or some masonry used alone or in combination with steel or wooden beams. Fig. 5 shows a stone pillar at the junction of a butt entry air-course and the face entry. Supports of masonry must be considered as perfectly rigid and are used to prevent the roof from bending and subsequently falling. After a weight greater than its compressive strength has been applied to a support of this kind it is of no more value.†

Concrete or masonry arches and concrete or masonry walls with steel beams are gradually eliminating timber sets with lagging, as mine portals, shaft bottoms, underground stables, pump houses, and other similar places where permanent work is important. In one mine there is approximately 1 mile of concrete and brick lined entry. Fig. 6 shows the use of concrete for mine portals, steel ties imbedded in a concrete floor and a steel tipple. This is one of the places where substitutes for wood have been found advisable.

A concrete or masonry wall built along the haulageway to support the cross-beams acts both as posts and lagging and should a trip of cars become badly wrecked there is no danger of the end supports of the cross-beams becoming dislodged and allowing the roof to fall. Where concrete or brick walls for the end supports of beams are built they should be solid up to the top of the car and then pillars for the beams may be built on top of wall.

*Mines and Minerals, Vol. 18, p. 552; Vol. 28, pp. 128, 294; Vol. 20, pp. 289, 388; Vol. 27, p. 76; Vol. 32, pp. 321, 385, 538, 641, 751. The Colliery Engineer, Vol. 33, pp. 99, 219, 535, 537, 598.

†Mines and Minerals, Vol. 31, p. 749, "Mine Support Tests."

Steel sets are frequently used on the permanent haulage roads of airways as mine roof supports in place of wood. Discussion on this phase of timbering has been thoroughly covered in papers read before this Institute and elsewhere by R. B. Woodworth, of the Carnegie Steel Co., in which he keeps this important topic up to date and constantly before the attention of mining men.*

The first cost of steel supports erected is usually two to three times that of wood, but the cost is usually warranted by the increased life and by the expense sometimes necessary to clean up a fall and renew timbers that have failed. Another important item for consideration in this matter of cost is the reduced output caused by blocking a haulageway by unexpected failures that must be cleaned up during the day shift. Fig. 7 shows what often happens where wood is used and what one could have expected here had the entry not been lined with reinforced concrete. This picture was taken in the Bruceton experimental mine after an explosion. Comparative tests between steel I beams, steel rails, white oak, chestnut, and white pine, by A. W. Hess, of the Consolidation Coal Co., show that a 4-inch I beam will do the work of an 8-inch round timber.

Fig. 9. Steel Prop

*Mines and Minerals, Vol. 31, pp. 387, 516, 563, 664; Vol. 32, p. 215.

A sixth substitute for wood in a mine is the use of steel or iron props at the face. This practice is possible only where the props can be recovered or in that portion of a mine where it is possible to recover the props before they have become overstrained to such an extent that they must be straightened, repaired, or sold for scrap. Rigid props fail upon a compression of a very small per cent.; they are used to keep the roof in place and prevent it from starting to give, as may be illustrated by referring to a tender shale above a flexible roof coal, where the prop is to hold the roof coal up against the shale; another use is to support the roof where the roof or floor as a whole are unyielding. Steel props can be made yielding by combination with wood or by allowing a part of the prop to rest in a cavity filled with peat or other loose material. The yielding steel prop is probably used in Germany more than any other country.

The steel prop giving the best design from a structural standpoint is the pipe. This has been tried in the anthracite region when great supporting power was necessary. The pipe was cut to length and a flange placed on both ends to increase the bearing surface. Scrap pipes from old culm lines have been used in underground stables and such places by filling the interior of the pipe with concrete. The most economical design of steel to withstand compression is the H-section beam where the radius of gyration is more nearly equal about both axes. This design has been used in England since about 1890 and is now quite common. It has also found a market in the anthracite district to a limited extent. The chief drawback in both the pipe and H section is the inability to readily change the length to suit conditions. This has been overcome in several different ways. The screw-jack head shown in Fig. 9 was used in a bituminous mine of Pennsylvania about 1906. These props were made to protect a coal conveyer in long-wall work but they would also be of

advantage in many mines as temporary props under draw slate for protection in taking down bad roof.

Another form of adjustable prop consists of a channel bar with a T beam telescoping into the channel, the lower end of the T beam is slightly wedge-shaped. The T beam which contains horizontal slots is raised to the proper height then forced against the roof by iron wedges being driven into the slots in the T beam and resting on the band on top of the channel bar. A wooden wedge is then driven in between a movable ring and the wedge-shaped end of T beam. The iron wedges through the T beam are then removed and used at the next post. An oval-shaped bolt is provided for use on the back side from the wedge, and when it is desired to remove the prop this bolt is given a one-quarter turn which turns it to the flat side, loosening the wooden wedge and allowing the prop to collapse. The compression of the wedge allows the props to yield at a load of 15 tons which is regulated somewhat by the kind of wood used for the wedge. This prop has found use in both Germany and Belgium.

The Mannesmann weldless steel props consists of two pipes, one telescoping into the other so that they can be adjusted to the proper height. They are held in position by a clamp which is attached on the outside of the prop in such a manner that it cannot slide down. It is claimed that the clamp can be screwed to a resisting force of 15 tons, after which time the telescoping will proceed as that weight is being applied. Good results have been obtained by using these at gate ends and to the first waste conjointly with tapered props. These props, as the ones above, can be easily removed from a distance.

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It is stated that over a dozen men who got their first knowledge of medicine in the first aid corps in the anthracite regions continued their studies, took degrees, and are now regular practicing physicians.—*P. & B.*

Reminiscences of Early Anthracite Mining

*By John Hale**

In the early mining of coal in the Lackawanna Valley the miners did not possess the advantages available today. Their duty besides that of mining coal consisted of numerous other things. For instance, we had to go to the timber yard and cut our own props, load them on cars, and stay with them till they reached our working places. Ties and mine rails demanded similar attention.

The slope at the Bellevue mine was sunk to the Diamond seam in 1852. A little later it was extended on a 15-degree pitch to the Rock seam which lies 28 feet below.

The machinery for this work was manufactured by Weiss, Lippincott & Miner, at Mauch Chunk, and hauled over the mountains to Scranton by mules. The engines not only did the hoisting but they operated a Cornish pump as well.

The rod for this pump was of 8″ x 8″ timber and was carried down one side of the slope on rollers. The pump cylinder was 10 inches or 12 inches in diameter and it had a stroke of about 4 feet. The column pipe was 8 inches in diameter. The mine cars were hoisted up the slope by a "barney" or pusher.

The breaker at this time was probably the first in the region that employed toothed rolls to break the coal.

As to wages, company miners in 1856 were paid $1 per day, laborers $.75 per day and then had to find their own oil and tools. The price paid per car, which contained slightly more than 2 tons, was $.55 in summer and $.50 in winter. The coal had to be clean and all fine material was thrown into the gob. Each miner was obliged to have a rake, the teeth of which were about 2 inches apart. Powder was $3 per keg and oil was $1.25 per gallon.

When I first came to Scranton in the year 1856, few railroad locomotives burned anything except wood. About 2 years later some us of were ordered to send out the very best and cleanest coal. It had to be all lump coal and we loaded it with our hands. It was tried out on the locomotives and soon all the miners were ordered to load the very best coal in separate cars and were paid 5 cents bonus on each car for so doing.

At that time there was but little demand for the smaller sizes. Stove coal was the smallest size prepared and before the breakers with roller teeth were introduced the coal was broken with hammers and picks and forced through large holes in cast-iron plates; the holes were about 4 inches square. These plates were placed at the bottom of the grate bars so that all of the coal that did not go through the grate bars landed on those large plates. The plates were 3 or 4 feet square and about 4 inches thick. Until a breaker was built several years later, the screens were driven by mules and loading was done by hand shovels.

One of the first chambers I had to work was about 300 feet from the slope bottom. It really was the gangway that had been driven from the slope but had encountered a sharp rise, so it was stopped as a gangway. About 4 feet of the bottom had been taken up, and as the bottom bench of the coal was 8 feet thick, it made a height of chamber of 12 feet and it was usually full of gas each morning. There were no fans, furnaces, parallel entries or fire bosses at that time, so we had to do the best we could. One morning the gas filled the chamber from roof to bottom. I took my old coat and brushed until I was tired but could not move it, there being no air to carry it away. The face was about 75 feet beyond the last opening, so I gave it up in disgust. I then went out and reported the conditions to the mine foreman. He scratched his head and smoothed his whiskers, then said he would fix it all right, so he sent his handy man down with some wooden rails and a load of boards with instructions to begin work at the branch and put up a roof about

*Scranton, Pa. See Editorial.

6 feet from the rail so as to divide the gangway horizontally and to cause the air to return over this roof. Of course I was very anxious to see the result. After working several days we managed to put up this roof. The next morning the "boss" fully expected to find it all clear, but instead we found both stories full of gas. After brushing and whacking away until we were exhausted I took a safety lamp and found the gas still there. "What can we do now?" was the next question for the mine foreman. He finally decided to get a small fan and place it as near the face as possible and yet be safe from the blasting, with a small boy to turn it. This the boy did when he felt like it. We had to be on the lookout for fear he would turn the fan when we were not aware of it and blow the gas on our lamps. Such conditions compelled us to use safety lamps most of the time. After battling in this way for some time I was ordered to raise the road up on the bottom, but the gas was still there and many times I found it down to the rails. Still with all the danger we escaped any serious explosion. We had naught to do save battle with it or go home.

After driving the chamber the desired length we began to take down the top coal which was about 7 feet thick. One morning after we had blasted a fall of this top coal down, the hole was as full of gas as an egg is of meat. The little fan in the meantime had been taken away. Now we were up against it again, and could not send out our coal, and again the question "What could be done?" After explaining the condition to the foreman he concluded to put up a stage or high platform which was made by the mine carpenter and have a man to brush the gas out as best he could. We kept him there for 3 or 4 months, when we had made a larger hole and the gas diminished.

It must be borne in mind that there was no system whatever to mining in those days. Coal was taken out indiscriminately. The motive power was supplied entirely by mules, steam locomotives being first used about the mines about 1875. Rails were of 3 by 5 scantling. Tee rails were first used for gangways and rooms in 1865. Ventilation was entirely of a makeshift order, and it was in 1869 that I drove the first parallel airway in the mine.

The most noticeable improvement in recent years are those in haulage and ventilation methods. Until parallel airways were driven there was no marked improvement in the condition of the mine atmosphere. The roads were at first very poor and crooked, being driven at water level. These were improved insofar as the pillars would permit, skips being taken from the ribs to modify the curves.

Some years ago when it was decided to sink a new shaft directly underneath the breaker so that the coal could be hoisted direct to the dump, the question arose "How can it be managed without interfering with the working of the breaker?" I was the mine foreman at that time and the officials told me to use any scheme I might have.

The first thing I did was to plumb the tower of the breaker from the point where the sheaves would be located, and then took my transit to locate the angles of the shaft. I then had a bore hole driven to the Diamond seam which was 28 feet below. We erected temporary engines and put the rope through this bore hole and then drilled another for a signal wire. After setting up my transit under the first bore hole I located the corners of the shaft and then started to sink a small shaft to the Rock seam 30 feet below. The rock was hoisted in buckets by a windlass and gobbed away in the old workings. My reason for sinking such a small shaft to the Rock seam being the ease with which the rock could be handled when it was widened by letting it fall to the seam below and then carry it away. When the total depth of 257 feet from the surface was reached we encountered the bottom seam and then we finished the timbering, broke through the surface above, connected the guides, and coal was hoisted without the breaker losing a day's time.

During my experience with miners I found them to be a hard working class of men, working harder than most men, and spending their money more freely than any other class. I also found them to be venturesome and courageous, always ready to give aid at a moment's notice when anything was wrong. No class of men are surrounded with so much danger as are the miners and none are so reckless in the matter of personal safety as these men are today. And yet there are more laws on the statute books of this state for the health and safety of the miners and laborers than for the workers of all other trades combined.

In my 34 years as mine foreman of the Bellevue shaft mine of the Delaware, Lackawanna & Western Railroad Co., we mined about 5,000,000 tons of coal with a loss in life of but fourteen, including miners, laborers, and company men.

By-Product Coke Plants

In the "Mineral Resources," for 1912, the production of gas, coke, tar, and ammonia from by-product ovens shows an enormous increase since 1903. In 1912, 34 by-product coke works produced 11,115,164 tons of coke, worth \$3.84 per ton. The surplus gas from the ovens amounted to 54,491,248,000 feet, and its value was estimated at 8½ cents per thousand feet. The reason for the decline in price from 15 cents in 1911, is because the steel works producing by-product gas sell it to another department at a nominal figure, but when it is sold outside, the gas brings from 15 to 30 and even 90 cents per thousand cubic feet, according to locality and its nearness to natural gas. In 1912 there was 94,306,583 gallons of tar produced from distilling coal in by-product ovens, and sold for 2.8 cents per gallon, or about 28 cents per ton of coal.

The Electra Mine

Description of a Modern Central Iowa Coal Mine Operated by the Consolidated Indiana Coal Co.

By William Z. Price

NEAR the town of Melcher, in Marion County, Iowa, the Consolidated Indiana Coal Co. has put into operation one of the finest mines in the state. The mine is reached by the Chicago, Rock Island & Pacific Railway.

FIG. 1. NEW MINING TOWN OF ELECTRA, IOWA

At this place the company controls 5,000 acres of coal land, and has erected a steel tipple over the elliptical shaft which is lined with concrete from the top to the bottom, 200 feet.

The shaft is the one described as the Dallas shaft in THE COLLIERY ENGINEER on page 31 of Vol. 34. The arrangement of the structural steel work of the shaft is such that the principal members are placed vertically instead of horizontally. In each section there are eight 7-inch I beams of 15 feet in length placed vertically, four near the outside corners of the cages, two in the middle at either side, and two on the ends where the guides are fastened. The I beams are fastened together on the outside with curved angle irons bolted to the flanges of the beams. These are spaced 5 feet apart and 2-inch lumber lagging is used to prevent the caving of the material. Quarter-inch iron rods run through the angle irons; these subsequently are imbedded in the concrete. After the steel work was completed, the concrete work was yet to be done. This was begun in October, 1912, and put in from the bottom to the top by clamping short form panels to the inside flange of the upright I beams. The wall is 7 inches thick and was completed in 2 months. The outside lagging was left in place, with openings at intervals to permit the concrete to tie firmly to the surrounding rock.

The tipple is modern in every respect. The coal from the mine dumps into the hopper and after passing over a 1⅜-inch bar screen drops into a weigh basket which has a two-way gate according to whether sized or run-of-mine coal is desired. The screening equipment, furnished by the Webster Mfg. Co., is similar to that seen in other modern tipples. The screenings fall through the bar screen into a Webster conveyer, 140 feet long on a pitch of 17 degrees, leading to the screenings or slack bin. Three motors are used for the tipple machinery, a 20 horsepower for the shaking screens, a 15 for the conveyer, and a 10 for the picking table, all of General Electric Co. manufacture.

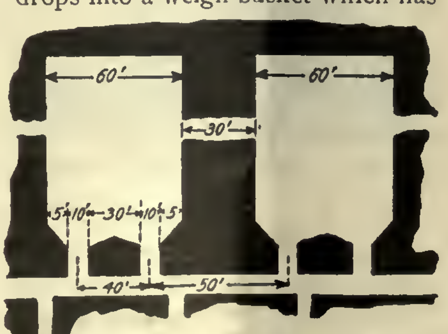


FIG. 2. METHOD OF MINING

The second opening to the mine is a combination airway and manway. It consists of a slope driven 16 feet wide, with 4-inch concrete walls on either side and a partition of the same thickness, making the airway and the manway 8 feet and 7 feet wide, respectively. Both are on a 17-degree pitch, the manway being 555 feet long. The airway continues 385 feet to an 8′ × 8′ shaft, extending 45 feet down to the coal. The method of mining the rooms is shown in Fig. 2. A 5-ton Morgan-Gardner gathering electric locomotive is used and an 8-ton Goodman for haulage purposes. The arrangement at the bottom of the shaft is

shown in Fig. 3; 6-inch Carnegie steel I beams are used on both sides of the shaft, and Carnegie steel mine ties are used in some parts of the mine.

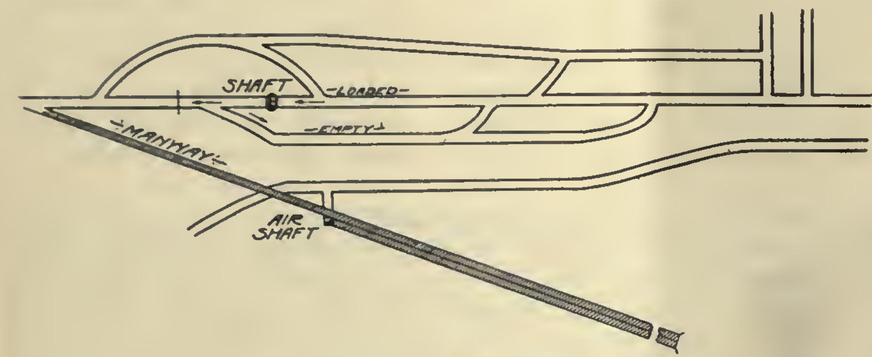


Fig. 3. Shaft Bottom, Electra Mine

The hoisting engineer is in the tipple and not in the engine house. The electric hoist is of 300 horsepower and made by the Ottumwa Iron Works with a General Electric motor attached. Limit switches are used with this to prevent overwinding.

The engine room of the power house contains besides the hoist a 750-kilowatt General Electric Curtis turbogenerator, delivering 2,300 volts of alternating current, and a 100-kilowatt motor-generator set, delivering 250 volts of direct current for the haulage motors and mining machines. Gary water-tube boilers, with Illinois chain-grate stokers, and a Deane condenser comprise the power-room equipment. The ashes are blown out on the bank through a pipe by a jet of steam.

Since this will be the central power station for all future developments in the region by the company, the one side of the power house has been constructed of a temporary nature in order to provide for addition to the equipment if it becomes necessary.

A mining town has been laid out east of the shaft and promises to be one of the most modern villages, being quite unlike the ordinary mining camp. The houses are built on the cottage plan with porches, all of various design, and with their attractive painting do not present the box appearance of the ordinary miner's house. They are fitted with bath rooms, and have a water supply derived from deep wells. Arrangements are being made to light them with electricity. By offering superior living accommodations at reasonable rentals the company expects to attract the best available practical miners to this camp. One of the aims of the company has been to care for the safety and comfort of their employes in every possible manner.

Fig. 4. West Side of Tipple, at Electra

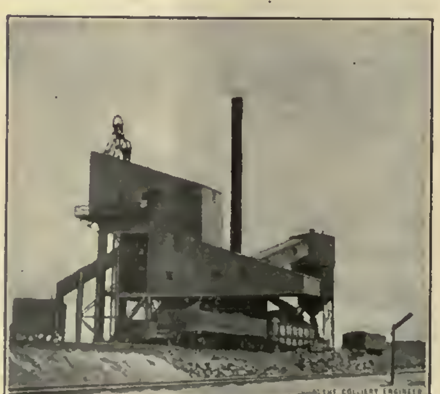


Fig. 5. North Side of Tipple, at Electra

Fig. 6. Hauling Rock to Dump

New York as an Iron Center

The Industrial Bureau of the Merchants' Association of New York, in a pamphlet recently published, states that it has decided to take advantage of the fundamental changes affecting the development of the iron and steel industry, and transfer Pittsburg to New York. Sound evidence of these intentions is found in Witherbee, Sherman & Co. having started to construct two blast furnaces on New York harbor which together will produce 800 tons pig iron. The booklet goes on to tell how the iron and steel industry is dependent upon the transportation costs for assembling raw material and distributing the finished products. A New York location, it points out, can furnish the producer with a greater variety of iron ores at lower costs than any other locality in the United States. Then by making use of by-product ovens and selling the by-products, Pittsburg will be a dead issue so far as eastern trade is concerned. For instance the cost of placing Lake Superior iron ores in Pittsburg is $2.03 per ton, in New York $1.75 per ton. The average melting scrap in New York City is $2.80 less than in Pittsburg. A number of other items are given to show how New York is a natural iron and steel center for production as well as marketing, as in years gone by. They do not advise Pittsburgers to sell their homes for a while, neither do they take into consideration that "westward the Star of Empire takes its way."

Maximum Coal Recovery

What Shall Be Considered Maximum Recovery with Modern Methods of Mining Bituminous Coal?

By A. W. Hesse

The Bureau of Mines informs us, in its Bulletin No. 47, that probably one-third of the bituminous coal now being mined is left underground by our present-day methods. In other words, the average recovery in bituminous fields is only about 67 per cent.

What will the next 10, 20, or 50, years show? Surely, if no better by the end of the last period of time, there is little hope toward eliminating these losses.

I have placed the subject of this paper in the form of a question, since I do not feel capable of answering it alone, but wish to bring forth a general discussion of this and a clause which so frequently appears in coal leases, and is closely connected with this subject.

What are the "most modern and approved methods of mining?" Apparently they are like our warships—modern today and obsolete a year hence.

In order to get an idea of what is being accomplished in other fields, inquiries were sent out to different sections of the United States. The results are shown in a condensed form by the accompanying table.

You will note on this table, the wide variation of percentages given for different districts in various states. All are large producers of coal, with one or two exceptions, and using what are presumed to be modern methods of mining. It is noticeable that the thin seams usually are overlaid with good roof; and the per cent. of recovery high. Also, but one operator expects the ultimate recovery to fall below his present percentage.

Colorado Field.—In the southern Colorado field where the roof and bottom conditions are favorable for pillar drawing, no roof coal is left for protection, and the recovery is given as 80 to 90 per cent., working the coal on the room-and-pillar system. It is claimed that in the Cañon City district where the longwall system is used, that 100 per cent. of the seam is recovered. This is in the thinner seam which measures about 3 feet.

The coal in this section of the country belongs to the Cretaceous series, and the intrusion of dykes should affect pillar drawing considerably, inasmuch as they would make more difficult the breaking of the overlying strata.

Rooms in the southern Colorado district are driven 16 to 18 feet wide on 45-foot centers, while in the Walsenburg district where the coal is harder and less cover, rooms are driven 35 to 40 feet wide, leaving the same thickness in pillars, which are recovered by machine and pick work. Track is laid on each side of the room and frequently one or two cuts are taken off the side of the pillar with a machine before beginning pick work.

The bottom of the Colorado seams is usually slate of a soft character, which heaves when weight is thrown onto the pillars, making it necessary frequently to drive a skip along the pillar in order to reach the back end before beginning to draw it.

There are districts in this state where both roof and bottom conditions are unfavorable and much difficulty is encountered in breaking the overlying strata. In these sections the recovery is estimated to be 60 to 65 per cent. They lose perhaps 15 or 20 per cent. in roof coal because they cannot prop the strata next overlying the coal.

With the conditions just given, and most of these operations advancing under heavier cover, do you believe the present recoveries will be maintained?

Another company operating in practically the same fields states its recovery runs 75 to 80 per cent. of the entire seam; in some localities it runs over 80 per cent. while in others, owing to bad roof, will probably not exceed 75 per cent. In these mines they expect to ultimately recover a higher percentage owing to improved conditions, notwithstanding the fact that 60 to 75 per cent. of the accidents in this state (Colorado) are due to bad roof conditions.

This company is now driving the room entries to their boundaries and the last rooms are worked first, thus making it possible to draw the pillars on the retreat.

Michigan Field.—In the Michigan field, especially in the Saginaw district, the coal is in pockets rather than a continuous seam. The basin lies for the most part in a low flat country, and shafts about 200 feet, in the Saginaw district, are necessary to reach the coal. The coal averages about 3 feet and is of poorer grade than the Ohio and Pennsylvania fields, so its market is somewhat limited.

The top in these mines is usually block slate, while one mine has a fireclay roof, making it necessary to leave roof coal. Yet rooms are driven 40 feet wide with track along each rib. The rooms are driven 150 feet in length, and the miner pushes his cars from the working place to the entry. With the conditions just given, the percentage of recovery claimed is between 80 and 90. The 65 per cent. recovery given in the table (Item 4) represents the result of leaving pillars for surface protection within the city limits.

Illinois Field.—Going into central Illinois fields where the No. 6 seam is operated extensively, we learn of adverse public feelings and unsettled industrial and labor conditions which materially affect the percentage of recovery. Surface costing $100 to $250 per acre costs the operator two or three times these values in cases of subsidences, if the mining rights do not clearly cover the property. Besides these factors, the companies operating in the Glen

Carbon, Mt. Olive, and Divernon fields state that, owing to very thick soft clay under the coal or great overburden (300 feet to 400 feet), they do not recover more than 50 per cent. In the southern fields they claim better results, since the cover is about 110 feet thick and all soft.

The slightly inferior seams of coal above or below the Nos. 5 and 6 seams are now receiving considerable thought as to future values, and for this reason they are trying to prevent roof movements by leaving sufficient pillars.

In the Sherrard field, of Illinois, the recovery is reported as 90 per cent. Here the top and bottom are good and conditions propitious for drawing pillars. The seam of coal is only 3 feet 6 inches thick, with many clay veins running through it, which evidently must affect recovery to some extent.

Pennsylvania.—An inquiry sent into the southwest section of Pennsylvania shows a recovery of 72.5 per cent. Here, 10 inches of roof coal is allowed to remain on account of draw slate, and the operations for the past 3 years have been under their plant and town.

The bottom in this mine is fireclay of rather soft character. The rooms are driven from both sides of entries on 60-foot centers and widened to 21 feet, leaving 39-foot pillars to be drawn by machine and pick work. By this method, the recovery is expected to show a material increase over that which has been given.

The company reporting from Westmoreland County, Pa., where conditions seem favorable, both in the steam coal and gas coal fields, shows a recovery of from 82 to 86 per cent. of the entire seam; and expects the ultimate recovery to fall below these figures.

Over in Somerset County, Pa., where coals of the Allegheny series are worked, the recovery is given as 94.75 per cent. of the entire seam. Here, they have excellent roof and bottom conditions, and I understand that all room headings are driven to the limit before any rooms are driven at all. Then, the rooms are started at the rear and pillars drawn as soon as rooms finish.

Maryland Field.—Practically the same conditions exist in the George's Creek field in operating the Sewickly seam, only the recovery is reported as 97 per cent. of the entire seam. In this same field, the results obtained in the "Big Vein" or Pittsburg seam, show 88 per cent. Considerable propping is necessary, owing to the draw slate just above the main body of coal and the wild coal just above this. The systems of mining the coal in this field have changed from time to time until now headings are driven 9 feet wide, rooms only 13 feet wide and the distance between room centers maintained at 100 feet, thus providing against squeezes. Under this process, 90 per cent. extraction is expected.

Ohio Field.—In Ohio, as well as some parts of West Virginia, no attempt is made to draw pillars at all. Rooms are driven 25 feet wide with 8- to 12-foot pillars between. In one of the largest mines of Belmont County, rooms were driven from both sides of the headings and it was no infrequent occurrence to have a territory squeeze shut, leav-

TABLE OF PRINCIPAL FACTORS GOVERNING RECOVERY OF COAL IN DIFFERENT DISTRICTS

Item	Operating District and State	Per Cent. of Recovery Entire Seam	Ultimate Recovery Compared to Present	Period of Operation Years	Average Height of Seam	Roof Coal Carried	Nature of Top	Nature of Bottom	System of Mining	Are Pillars Drawn?	Clay Veins Encountered	Remarks
1	Southern Colorado	80–90	Same	5 to 30	8½′	24″	Slate	Soft slate	Room and pillar	Yes	Dykes	
2	Colorado (other districts)	60–65	Same	5 to 30	8½′	18″–24″	Very soft	Soft slate	Room and pillar	Yes	None	
3	Colorado (other districts)	75–80	Better	10–35	3′–7′	Few places	Sandstone, poor shale	Same as top	Room and pillar	Yes	None	
4	Saginaw District, Michigan	65 80–90	Better	15	3′	Mines, 1 of 10	Black slate	Fireclay	Room and pillar	Where allowed	None	Length of room 150 feet
5	Central Illinois	50	Same	20	8′	None	Slate, clod, and limestone	Fireclay	Panel system	None	None	Advocates retreat mining
6	Southern Illinois	65–70	Same	20	8′	Yes	Sandy shale	Fireclay	Panel system	To some extent	None	No. 6 seam
7	Springfield District, Illinois	55–75	Increase*	20–25	6′–7′	Some places	Hard shale	Fireclay	Room and pillar	Where allowed	None	*Adjustment of labor situation
8	Franklin, Williamson, and Saline counties, Ill.	55–75	Increase*	18	5½′	Some places	Hard shale	Fireclay	Room and pillar	Where allowed	None	
9	Sherrard Field, Ill.	90	Same	20	3′ 8″	None	Blue rock and cap rock	Slate and sand rock	Room and pillar	Yes	Yes	
10	Extreme southwest section, Pennsylvania	72½	Better	3	7.48′	10″	18″–3′ Draw slate	Soft fireclay	Room and pillar	Yes	None	
11	Pennsylvania, Westmoreland County	84	Below	25–35	6′ 8″	None	Slate	Fireclay	Room and pillar	Yes	None	
12	Pennsylvania, Somerset Field	95	Same	8	3′ 11″	None	Hard black slate	Limestone	Room and pillar	Yes	Very few	Projected work adhered to
13	Maryland, Georges Creek Field	97	Same	12	3′	None	Sand rock	Sand rock	Room and pillar	Yes	Yes	Sewickley seam
14	Maryland, Georges Creek Field	88	Same	94	9′	18″	Gray shale, coal, dark shale	Hard gray shale	Room and pillar	Yes	None	
15	Ohio, Belmont County	60	Same		5′ 6′	None	Slate and shale	Fireclay	Room and pillar	None	None	
16	Eastern Ohio, Harrison County	70–75	Same		3′ 8″-5′	None	10″ firm slate	Pircclay	Room and pillar	None	None	
17	West Virginia	90	Same	50	8′	Some places	Varies	Fireclay	Room and pillar	Yes	Yes	
18	Alabama, no reply											
19	Tennessee, no reply											
20	Kentucky, no reply											
21	Kansas, no reply											
22	Iowa, no reply											

ing considerable blocks of coal between the ends of unfinished rooms. In this mine, 50 per cent. would more nearly reach their recovery. In Harrison County, Ohio, it is nearly as bad. The recovery is reported as 70 to 75 per cent., but the same conditions exist in this section as given for Belmont County, excepting perhaps the driving of rooms both ways from the same entry. The Ohio Mining Commission found in its recent investigations that 30, 40, and as high as 50 per cent. of coal is being left underground as pillars in that state.

West Virginia Field.—There are mines in West Virginia which show recovery from 85.6 to 99.8 per cent., the highest percentage resulting from the fact that all the work was in the solid. These figures were presented by Mr. W. A. Grady, of the Pocahontas Coal and Coke Co., at the last meeting of this Institute at Charleston, W. Va. The average result of the figures presented for 10 mines showed about 92.6 per cent.

From the foregoing figures, it is seen what is possible, at the same time what is actually, presumably, being accomplished. Shall we assume that because the United States Coal and Coke Co., at Gary, W. Va., are recovering 95 per cent. and more, of the coal in which they are operating, that this should be accomplished in the districts of Colorado, showing only 60 to 65 per cent.?

None of us, I am sure, would accept an average of the percentages here given as a fair maximum, nor even an average of the same field. It is unfair to compare ultimate recovery of mines now drawing to a close with those mines at the best of their production. No doubt, the systems under which they were inaugurated were considered modern. The most of us know that they would not be considered so now. Also, conditions made at that time now make it either impossible or prohibitive to go after the most of this abandoned coal.

From reports sent in, it is apparent that there are five factors limiting the possible recovery in these fields; namely:

1. Mining rights and public feeling.
2. Roof and bottom conditions.
3. Weight and character of overburden.
4. Labor conditions.
5. Market value of the coal.

1. Where the mining rights do not allow breaking of surface, the recovery naturally varies inversely in some ratio to the overlying weight.

2. Where roof and bottom conditions make it necessary to recover as quickly as possible, market conditions will affect recovery; for pillar work of this kind will not wait.

3. Weight and character of overburden requires systematic mining and competent supervision.

4. It is a matter of what is next best when unions insist on conditions which increase both cost of operating and loss of coal.

5. The market value of the coal dictates how far any of us can go toward recovery of coal.

The points are mentioned because we are so apt to compare straight figures of recovery without taking into consideration the conditions under which they are derived. The Ohio Mining Commission, for instance, uses the mines and operations at Gary for an example of what Ohio should follow. Conditions, however, are so different in these two localities, that to expect the same results in recovery will require several radical changes. Generally the roof in Ohio is poor, union scales require rooms entirely too wide for economic pillar drawing, the general labor situation is always more or less unsettled, and the selling qualities of the coal are inferior to the Pocahontas seam at Gary.

There are always conditions which affect good pillar recovery, three of which were given by Mr. H. V. Hesse, in his paper read before this Institute at Charleston, W. Va., December 1, 1908; namely, (1) Insufficient or incompetent engineering. (2) Incompetent management. (3) Impatience of owners for quick returns.

Maximum recovery in any one mine is hardly to be based on what is being done in some other section or state, or on the average of the same region, or even adjoining mines. The quality of the coal may affect this. For instance, I have in mind an operation in which at least 18 inches of the top coal is so poor that to mix it with the balance of the product would simply throw the coal from that mine off the market, yet right in the adjoining property the coal is taken on the first mining to the full height of seam. Besides having the much inferior top coal, this mine has also poor roof. In such a case should the recovery be based on the full height of seam or only on the portion that is salable?

Suppose that a body of coal was such that the market demanded it only during seasons of scarcity, other times the mine ran one-half or one-third of the time. This mine has a fireclay top which disintegrates by contact with air, thus making it both dangerous and expensive. Owing to the inferior conditions, the management placed here, both outside and inside, is not the highest priced, consequently not the most efficient. The system of mining is that generally followed throughout this particular field. What per cent. of recovery could be considered the maximum? Is an operator required to conserve his commodity at prohibitive costs of production? Must he follow the general system of the region, even though his recovery may be much lower than the general average, and his cost of production much higher?

Many mines have advanced a considerable distance in their development, but few are provided with sufficiently large barrier pillars along the main headings to give reserves for the final mining. The most of us know that the extraction of heading stumps on one side and a barrier pillar of 100 or 150 feet on the other side is a slow process with

small output, and I have wondered what effect the recovery of these barrier pillars will have on the ultimate recovery in a good many mines. Personally, I feel that the present high recoveries cannot be maintained to the end. Nature does not yield to us without effort on our part, and our efforts are on the increase while the capacities remain practically the same. There will be a period in the life of many mines when operations must move rapidly to keep down costs of production. Naturally, the quickest methods will be adopted and I need not say what they will be.

To tell what the maximum recovery should be under modern methods of mining appears premature, but certainly there are many factors which should be considered when a question such as the subject of this paper arises.

I desire to express my thanks to those who have so willingly answered the inquiries which went to making up this paper.

Waste Heat vs. Coal Under Boilers

Relative Economy Shown by Direct Use of Fuel and Waste Heat from Coke Ovens Under the Same Boilers

*By J. C. Edwards**

ONE of the greatest industries in Western Pennsylvania is the manufacture of coke for metallurgical purposes. As now carried on it is the most wasteful enterprise in the world, as about 35 per cent. of the heat units in the coal are lost and all the by-products. Here and there attempts have been made to save the waste heat by using it under boilers, and in this article the results obtained from this practice are compared with coal firing at the boiler plant of the Marianna mine of the Pittsburg-Buffalo Coal Co. This comparison furnishes data of actual practice and no assumptions need be entertained.

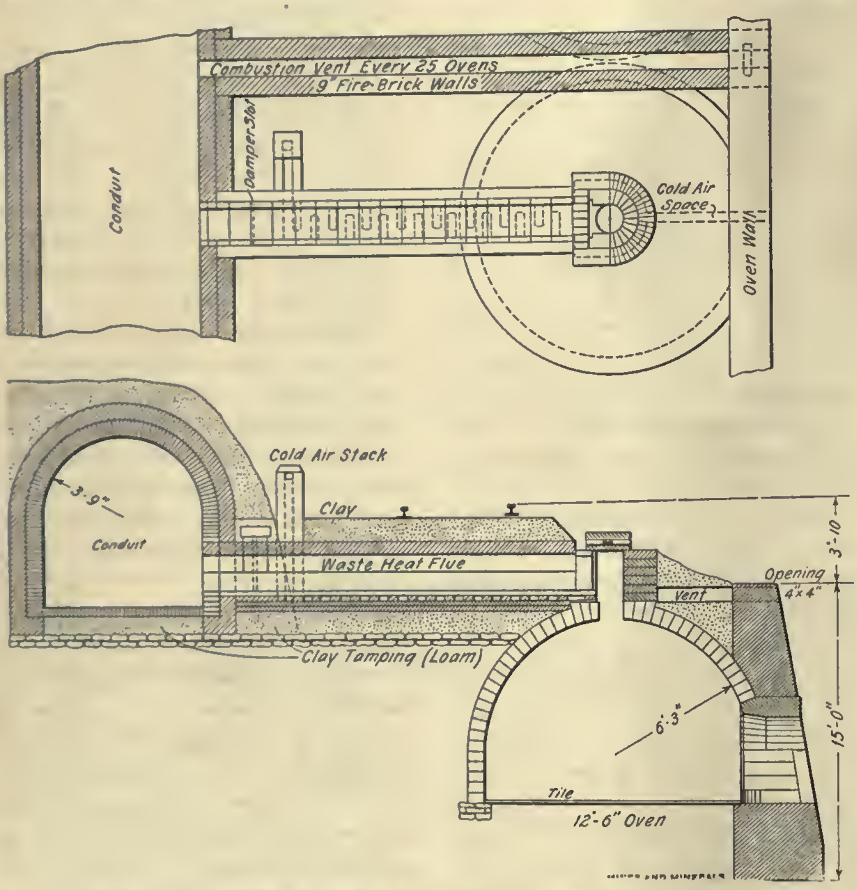


Fig. 1. Plan and Section of Coke Ovens and Waste-Heat Connections

The boiler plant at Marianna, consists of seven Stirling boilers of 500 horsepower each. Boilers Nos. 5, 6, and 7 are equipped with the Jones underfeed stokers; boiler No. 4 is equipped with the Babcock & Wilcox chain-grate stoker, and coal screenings are used under the four boilers. Boilers Nos. 1, 2, and 3 are attached to the Kearns waste heat system and are also equipped with the Green chain-grate stoker, so the fuel can be used under these boilers during periods that it is impossible to secure the necessary washed coal for coking purposes in the waste-heat ovens. Boilers Nos. 5, 6, and 7 have forced draft, an 8-foot fan with a speed of 350 revolutions per minute installed in the boiler house floor being used for the purpose. Boilers Nos. 1, 2, and 3 have stack draft only. From the above description of the boiler-house plant, a comparison between the labor and fuel costs of boilers Nos. 5, 6, and 7 and the waste-heat costs of boilers Nos. 1, 2, and 3 should be convincing, and the reader would be justified probably in accepting such comparisons as definite.

In propositions of this kind the only absolute comparison would be one in which waste heat and fuel were used under the same boilers, and this is precisely the comparison made in this article.

A short time ago coal was used in the waste-heat boilers Nos. 1, 2, and 3 for a period of 1 week. This afforded an opportunity of ascertaining the amount of coal consumed by these three boilers, under everyday working conditions. The amount consumed was 49 tons daily, and during this time an accurate account was kept of the labor and fuel cost in operating these three boilers. It is this account that makes it possible to compare the difference in cost between waste heat and fuel.

*Allison, Fayette County, Pa.

Daily Cost of Operating Boilers Nos. 1, 2, and 3 With Fuel

2 water tenders at $3 per 12-hour day	$ 6.00
1 repairman at $3 per 10-hour day	3.00
1 larryman (coal and ashes) at $2.25 per 10-hour day	2.25
1 man feeding stokers at $2.25 per 10-hour day	2.25
3 firemen at $2 per 8-hour day	6.00
2 ashmen at $2.25 per 10-hour day	4.50
49 tons of coal at $1 per ton	49.00
Total	$73.00

Daily Cost of Operating Boilers Nos. 1, 2, and 3 with Waste Heat

2 water tenders at $3 per 12-hour day	$ 6.00
1 repairman at $3 per 10-hour day	3.00
1 man removing dampers from ovens at $2.50	2.50
Total	$11.50
Daily cost with fuel	$73.00
Daily cost with waste heat	$11.50
Daily savings in the use of waste heat	$61.50

In a year of 300 working days, that the boiler plant is in operation, the saving in labor amounts to $3,750, the saving in fuel amounts to $14,700, or a total yearly saving of $18,450, which represents a trifle more than the cost of installing the waste-heat system.

It seems that some do not realize what an immense saving could be accomplished in the Connellsville region by this means, but all are compelled to acknowledge the possibilities when confronted with the concrete facts that the utilization of waste heat represents a yearly saving of $12.50 per boiler horsepower, and that every oven used in a waste-heat system is equivalent to 20 horsepower or a yearly saving of $246.

The waste-heat system at Marianna consists of 75 beehive coke ovens, 12 feet 6 inches in diameter connected to a conduit, parallel with the oven battery by waste-heat flues. The boiler plant is directly opposite the upper end of the conduit. The ovens in this battery are used to manufacture 48-hour coke, and under normal conditions the men start to draw coke from the ovens at 7 p. m., and by 5 a. m. all the ovens are charged with coal. The charges are a little heavier than the usual 48-hour charge for beehive ovens, which increases the yield of coke. In this system the heat is taken direct from the trunnel head, so that the process of coking is not interfered with, and only that heat which would otherwise escape into the air is used. After leaving the trunnel head, the heat is conducted through a 15-inch flue to the main conduit, where it mingles with the heat from the balance of the ovens and continues through the main conduit to the three waste-heat boilers.

The point in the main conduit where the waste heat enters from the oven is 6 inches higher than the point where it leaves the trunnel head. The main conduit maintains this relative position to the ovens throughout its length. The point in the main conduit where the waste

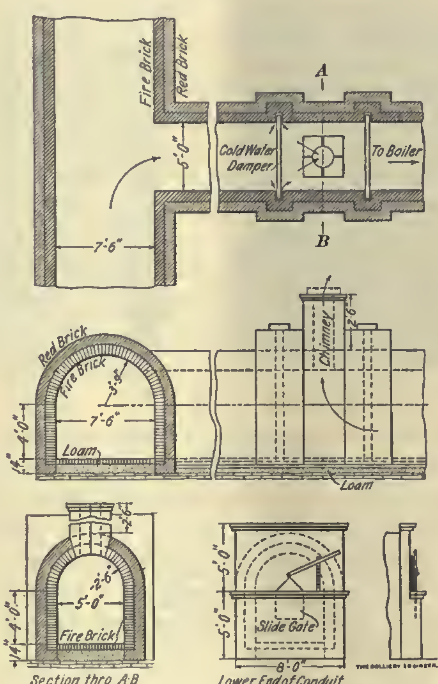


Fig. 2

heat enters the boiler house is 10 inches lower than the point immediately below the boiler tubes, so that the waste heat throughout the whole system is continually rising and its course is natural. The flow of heat to the three boilers is regulated entirely by the stack dampers.

In Figs. 1 and 2 the waste-heat flues and coke oven are shown in plan and section. In the construction of the oven, the trunnel head is continued up until height has been attained for the waste-heat flue. It is constructed in the form of a semicircle on the side toward the oven wall and on the side toward the conduit is constructed so as to form the entrance to the waste-heat flue. In Fig. 2 section *A-B* shows the construction at the connection of the waste-heat flue and trunnel head. There is a slot formed for a damper at this immediate connection, so that when the trunnel-head cover is removed, during the time of drawing and charging the oven, a 2-inch tile damper can be placed in this slot, thereby shutting off this flue from the oven. The trunnel-head damper consists of courses of firebrick, laid on edge, and held in place by an iron band on the center. The cross-section *A-B* shows the size and construction of the waste-heat flue. The longitudinal section shows the main conduit, waste-heat flue, and coke oven. Fig. 1 shows the method of construction in detail. The bottom of the waste-heat flue rests on two layers of brick laid flat. On top of this is placed firebrick in alternate positions on each side so as to form an irregular space, as shown on plan of oven. On this rest the 2-inch tile which form the bottom proper.

A 4" × 4" opening for cold air is left in the oven wall and a passage of this size is built so as to split and pass around each side of the trunnel head and join again at a point directly underneath the 2-inch tile of the waste-heat flue. From this point the course of the cold air is baffled by the brick upon which the tile rest. Its course is deflected to the base of the small air stack up which it passes to the free air. The object of the cold-air flue is to cool the brick in the trunnel head and waste-heat flue so they will not fuse. The inside course of the main conduit is constructed of firebrick and the outside course of common red brick. All the waste-heat flues are covered over with clay to protect them from cold and from stormy weather.

Fig. 2 shows the construction of the off-take from the main conduit to the boiler. The heat from the conduit passes through the off-take to a point directly beneath the boiler tubes. The opening at this point is throttled to a width of from 4 to 5 inches. The tubes are isolated from the firebox of the boiler by a brick wall, care being taken that this wall is practically air-tight.

The off-take to the boiler is constructed so that, in case of necessity, the boiler can be cut out in a few minutes. In Fig. 2 where the small pilasters are formed, there are two slots, which form a receptacle for two cold-water dampers. These dampers are constructed water-tight and coupled so as to be easily connected to the water line, to allow cold water to circulate through them when placed in the slots. Between these slots is a trunnel head with a damper placed over it while the boiler is in use. When it is found necessary to cut off the boiler from the waste-heat system, the two water dampers are coupled to the water line with a hose connection and dropped in place, then the cap or damper is removed from the trunnel head, so that any heat that would pass around the edges of the first damper would escape into the air. By using the second damper the flow of heat is shut off entirely from the boiler. The idea being to cool the boiler down as soon as possible.

Efficiency of Waste Heat.—To determine the efficiency of waste heat for boilers, the writer conducted an evaporation test in boilers Nos. 1 and 4, respectively. Fuel is used in No. 4 boiler and waste heat in No. 1 boiler and as both boilers have stack draft only, it was an eminently fair test, especially as it was made at the same time and during a period when the whole plant was in operation. The test was made from 10 A. M. to 10.15 A. M. and the evaporation of water, measured on the water gauge of the fuel-fired boiler was used as a basis for comparison. A few minutes before 10 A. M. the water supply was shut off from both boilers and at 10 A. M. the height of the water in the gauge glasses was marked by tying a string around the glass. At 10.08 A. M. No. 4 boiler had evaporated 1 inch of water, and at 10.15 A. M. 2 inches had been evaporated. During the same period of time, boiler No. 1 had evaporated 2½ inches of water.

Under date of January 27, 1913, the company chemist made a 24-hour test of the waste-heat boiler No. 2, which in itself is sufficient to establish the fact that efficiency is attained in the waste-heat boilers at Marianna.

Chemist's Report.—During the test three boilers were on coal and three on waste heat. No. 4 boiler being repaired.

The series of 24-hour tests showed a maximum temperature of 2,060° F. a minimum temperature of 1,840° F. and an average for 24 hours of 1,946° F.

The temperatures were taken at the breech of the flues, and it will be noticed that the temperature was lowest during the watering and charging period.

The outside temperatures ranged from 38° to 50° F. and the night of the test it rained from 8 P. M. to 10 P. M. with the temperature ranging from 55° to 50° F. At the time for the test, five ovens were out for repairs, leaving only 70 ovens in service. The whole plant was in operation from 7 A. M. to 4 P. M. and the day's run was 3,040 tons of coal. The writer is working on a control for these ovens and expects by his method to give the boilers more heat and not pull too hard on the ovens.

Proper Use of Waste Heat.—The secret of efficiency, in the utilization of waste heat, consists in using only that volume of heat, which would otherwise escape to the atmosphere, during the process of coking, thereby prohibiting a sacrifice in the quality of coke manufactured.

In this test the stack dampers, regulating the volume of heat used, were closed between 5 P. M. and 2 A. M., opened between 2 A. M. and 7 A. M. and during the period from 7 A. M. to 5 P. M. (which covers the time when the plant is in operation), the dampers were only half open, and during the same period an average temperature of 1,997° F. or practically 2,000° F. was maintained.

From this it is seen that the quality of the coke is not sacrificed by pulling too hard on the volume of waste heat. In fact the coke manufactured in the waste-heat ovens is the best produced at this plant.

The labor situation in the anthracite fields is quiet, though there have been a few "button" strikes here and there, and complaints are heard from many of the operators about agitators trying to stir up trouble among the mine workers who are glad of the increase in the number of working days during the summer months. From 1892 to 1901, the average time worked in the anthracite region was 179 days. Since the summer discounts went into effect in 1902, in only one year, 1906, when there was a long suspension, has the number of days worked fallen below 200. In 1913 it was 257.

Twenty-Four-Hour Test in Waste-Heat Boiler No. 2

Time	Temperature	CO_2	O_2	CO	Pounds	Air	Draft	Stack Temperature	Steam Pressure	Direction of Wind	Damper
8 P. M.	1,900	15.4	.8		.62	Excess	.2	560	120	S. W.	Closed
9 P. M.	1,890	19.2	1.3	.8	2.00	Excess	.2	550	135	South	Closed
10 P. M.	1,840	13.0	1.0	.6	1.50	Excess	.2	545	125	South	Closed
11 P. M.	1,850	11.4	2.6		2.22	Excess	.2	545	130	S. E.	Closed
12 M.	1,860	12.0	1.6		2.20	Excess	.2	545	135	South	Closed
1 A. M.	1,880	12.4	.6		1.90	Excess	.2	545	110	North	Closed
2 A. M.	1,900	11.2	1.8	.6	1.70	Excess	.3	530	100	North	Open
3 A. M.	1,940	11.8	.4	3.1	1.76	Short	.3	580	140	S. W.	Open
4 A. M.	1,995	10.2	.2	4.2	2.20	Short	.3	580	140	S. W.	Open
5 A. M.	2,000	9.4		6.2	4.24	Short	.3	590	115	S. W.	Open
6 A. M.	2,000	9.6		5.0	4.00	Short	.3	590	130	S. W.	Open
7 A. M.	2,020	10.4	.4	4.2	2.18	Short	.5	600	150	S. W.	Open ½
8 A. M.	2,060	10.0	.2	4.8	3.80	Short	.6	615	140	S. W.	Open ½
9 A. M.	2,040	9.6	.2	5.0	3.50	Short	.6	615	140	S. W.	Open ½
10 A. M.	2,020	9.8		4.0	3.80	Short	.6	610	140	S. W.	Open ½
11 A. M.	2,000	10.6	.1	4.0	3.00	Short	.6	580	140	S. W.	Open ½
12 M.	1,990	10.8	.1	3.8	2.10	Short	.6	590	150	S. W.	Open ½
1 P. M.	1,995	11.0	.2	3.8	2.00	Short	.6	580	150	S. W.	Open ½
2 P. M.	1,985	11.2	.1	4.4	3.30	Short	.6	580	140	S. W.	Open ½
3 P. M.	1,960	11.4	.1	4.2	2.80	Short	.6	580	135	S. W.	Open ½
4 P. M.	1,900	12.2	.2	2.4	1.95	Short	.6	580	130	S. W.	Open ½
5 P. M.	1,940	11.6	.2	5.0	2.90	Short	.3	580	125	S. W.	Closed
6 P. M.	1,920	12.0	1.0	2.8	2.80	Short	.3	575	130	S. W.	Closed
7 P. M.	1,940	12.8	1.2	1.6	.98	Short	.3	575	120	S. W.	Closed

Eastern Montana Coal Fields

Notes on the Tertiary Coal Fields of Eastern Montana—Possible Methods of Utilizing Lignites

*By Leroy A. Palmer**

FOR perhaps 50 miles east of the Bull Mountain field conditions generally seem to have been unfavorable to the formation of coal within a workable depth limit. Then at about Forsyth, the seat of Rosebud County, one reaches the great eastern Montana fields. From Forsyth east to the state line, a distance of about 125 miles, it is scarcely an exaggeration to say that the entire country is underlaid by coal. The writer drove up Tongue River, from the mouth at Miles City, to the Wyoming line, a distance in excess of 125 miles, and there was scarcely a mile in which outcrops of coal or indications of burning were not in sight.

Fig. 1. East Side Mine, Red Lodge, Mont.

Fig. 2. Montana Coal Outcrop and Burned Crop Line

A notable feature of the coal occurrence in this part of the state is the burning along the outcrops. The burning is usually indicated by a bright red color to the roof of the seam caused by the reduction of the iron in the overlying strata, a condition that frequently affects the compass needle. Frequently the coal has burned out over a considerable area and the reduction in volume has caused the roof to cave and break down of its own weight. The hillsides are abundantly strewn with "clinker" or slag, usually black, caused by the fusing of the overlying sands or sandstones. This clinker bears a marked resemblance to a lava that has been erupted thin and rapidly cooled. Often it is vesicular and some residents of the country who have had some smattering knowledge of prospecting have insisted that it is an igneous rock and have spent some time searching for lodes in its vicinity. A number of beds are still burning in this locality, occasionally, under proper atmospheric conditions, sending up a thin column of smoke.

There has been much speculation as to the origin of these fires. Human agencies have undoubtedly been responsible for many. One early settler stated that the Crow Indians had, in times past, done their fall hunting in that particular locality and had practiced the custom, after the hunt, of burning the range to drive the game out and thus remove that inducement to hostile tribes coming in. Other fires have been started in recent years by carelessness, but it is evident from the immense area burned over, and from such facts as that slag pebbles have been found in formations of an age antedating the present, and that there are numerous cases where a gulch has been eroded through the hard, burned, outcrop, showing the unburned coal back of it, that much of the burning was before the age of man and, consequently, was due to natural causes. Lightning, either by direct ignition of the coal or by starting prairie fires that have subsequently ignited it, has been frequently assigned as a cause, but the writer is inclined to the theory of spontaneous combustion. This theory has been advanced as to the oxidation of the pyrite in the coal, but most of this coal is free from pyrite to the naked eye, so it appears more reasonable to attribute the ignition to spontaneous combustion of the coal itself. All of this coal stores poorly and slacks readily when exposed to the air, so it would appear plausible that the outcrops would slack to such a degree that a pile of coal sufficient to incite spontaneous combustion would gather along them. In general the evidence of burning is considered as an indication that a thick bed will be found back from the outcrop, as it is usually the thicker beds that burn.

The general average of the coal of eastern Montana is far below that of the Carbon County and Bull Mountain fields, although in some portions it is similar to them. This is noticeable along the upper end of the Tongue River and its tributaries, which territory is adjacent to the Sheridan field of Wyoming and where the coals are similar to those of the latter. An analysis from this part of the field taken from a 12-foot seam on Cañon Creek was as follows: Moisture, 11.30 per cent.; volatile matter, 38.05 per cent.; fixed carbon, 46.75 per cent.; ash, 3.90 per

*Mining Engineer, San Francisco, Calif.

cent.; sulphur, .31 per cent. B. T. U., 10,700.

The similarity of the sample from Cañon Creek and the others mentioned is at once apparent, but it should also be noted that it is much lower in sulphur and ash.

In general, however, the coals of this field are not up to the above, as shown by the following average of six air-dried samples from various parts of the field: Moisture, 16.98 per cent.; volatile matter, 33.77 per cent.; fixed carbon, 39.25 per cent.; ash, 10 per cent.; sulphur, .87 per cent. B. T. U., 8,552.

The Cañon Creek coal is a typical subbituminous, while most of the others are typical lignites. They are often brown and of a very pronounced woody structure, showing knots and the grain of the wood. Even where found glossy black, a little search will reveal pieces showing the grain. All of them store very poorly and many of them air slack audibly when dug out of the bank in which they are found.

In connection with the geology of this region, it is interesting to note that a few miles west of Glendive a northwest-southeast anticline has exposed the Cretaceous Pierre shale and conditions are so favorable to the accumulation of oil that one of the large western oil companies is putting down wells to prospect this formation.

A feature of the topography of this region is the "bad lands" which are to be found along most of the larger streams throughout the eastern part of the state and cover a large area back from the Missouri River. The steep banks of these bad lands afford favorable opportunity to study the stratigraphy and they expose many outcrops of coal seams.

No mines which are really worthy of the name are operated in the eastern part of the state. There are several small properties of limited output worked in a more or less desultory manner, but nothing calling for such extensive operation and equipment as the Bull Mountain and Carbon County fields.

In general the coals of this region are in the Fort Union proper or at the contact of the Fort Union and the Lance formations. In certain portions of the district, however, notably the Little Sheep Mountain, Baker, and Terry fields, the Lance formation contains a large tonnage of workable coal, nearly two-thirds of the coal in the Baker field occurring in this formation. The Lance coals have a tendency to lenticular shape and are not so persistent as those of the Fort Union.

The Fort Union shows many beds of workable thickness. A 980-foot section in the Sidney field shows 49 feet of lignite distributed through 11 beds whose average thickness is from 2 feet 4 inches to 9 feet 1 inch and only two of which have an average of less than 3 feet. On Burns Creek one of these beds attains a thickness of approximately 25 feet.

So far little definite survey work has been carried on in connection with the coals of eastern Montana. Only six fields east of the Bull Mountains and south of the Missouri River have ever been studied in detail and these comprise only a very small portion of the great coal bearing region. Of the vast area south of the Yellowstone less than 3,000 square miles, the Baker and Terry fields, have been surveyed and mapped. These figures are taken from the reports of the United States Geological Survey, which has done all of the work undertaken in detail. The Survey has been prosecuting the work during the past season, but the reports have not yet been made public.

Some idea of the immense quantity of lignite in this part of the state can be gained from the reports of the Survey which has estimated the tonnage of three of the fields as in Table 1, the depth limit being 500

TABLE I

Field	Area Square Miles	Short Tons
Little Sheep Mountain	1,450	1,189,832,820
Baker	1,300	1,596,054,000
Sidney	800	23,329,830,000

feet, and only seams of a thickness of 30 inches or more being considered except in the Baker field where the minimum thickness was 36 inches.

This estimate is considered conservative, as only lignite beds actually seen and measured were taken into consideration. Due allowance must be made for loss in mining, but even placing this at 66⅔ per cent. there is a recoverable tonnage of nearly 9,000,000,000 tons. It may be that even this large allowance for loss in mining is low because, as mentioned before, conditions as to roof and floor are generally poor, and, except in rare instances, the beds are too deep for stripping and open pit work. But even allowing for the heaviest mining loss, the tonnage is stupendous. Moreover, mining will not stand still in the future any more than it has in the past, and it is safe to say that if these coals are ever needed for industrial progress a way will be found to win them.

As to what will become of this immense amount of lignite it is hard to say. The hydroelectric age is advancing, transmission lines are spanning gaps considered impossible a decade back, millions of horsepower that have been running wild in the mountains are being brought under control and one might almost venture the prediction that before these deposits are more than scratched they will be abandoned for the cheaper power except for the use to which they are now put, to serve the nearby ranchman seeking his winter's fuel.

On the other hand this portion of the state is far from the seat of hydroelectric development, the streams have slight fall and there are many natural resources which could be developed with cheap power. It may be that the solution of the problem will be found in the generation of producer gas and the manufacture of briquets. On account of the low grade of these coals and the fact that they stock so poorly, it is evident that resort must be had to some such methods. So

far the only work of this kind has been of a purely experimental nature on the North Dakota lignites, the results of which may be accepted as applying to the Montana lignites as well, as the two are of almost identical composition, as analyses will show. Inasmuch as these experiments furnish the only data available on the possibly extensive uses of this fuel they are abstracted freely from the published reports.*

An approximate average analysis of a large number of samples of dry coal used in connection with these experiments showed volatile matter, 40 per cent.; fixed carbon, 52 per cent.; ash, 8 per cent.

A reduction of the average analysis given above for eastern Montana lignites to dry coal shows volatile matter, 40.7 per cent.; fixed carbon, 47.3 per cent.; ash, 12 per cent.

The calorific value of the coals is considered to be about equal (dry coal) to 60 per cent. of that of Pocahontas and 65 per cent. of Hocking Valley, but it must be remembered that the heat value of the freshly mined lignite is greatly decreased by the excessive moisture (25 to 35 per cent.) which not only detracts from its heating qualities but causes excessive slacking besides making necessary the shipment of from 500 to 700 pounds dead weight in every ton of coal. Consequently, experiments were made to determine the possibility of increasing the heating value of the coal by the elimination of part of this moisture. In these experiments it was found that, by breaking the lignite to lumps that would pass a 3-inch ring and thus increasing the evaporative area, the slacking was materially checked. Further tests were conducted in air drying and it was found that simple exposure to the atmosphere for a period of two weeks resulted in a reduction of moisture from 33.5 to 12.5 per cent. with a corresponding increase in the other constituents and calorific value.

In order to make a practical comparison of the lignite with standard coals, a test was made with it and a select lot of Youghiogheny bituminous, by burning the lignite in different forms (small lumps, air dried, large lumps direct from mine, etc.) in a specially designed stove and under the same conditions as the bituminous, the measure of efficiency being the practical heating value of the fuel as gauged by its effect on the temperature of the room and the amount of water evaporated. The bituminous coal selected had a moisture content of 1.4 per cent. and analyzed (dry coal) volatile matter, 31 per cent.; fixed carbon, 61 per cent.; ash, 8 per cent.

By these tests the efficiency of the lignite on a basis of 100 per cent. for the bituminous is 40 per cent. for large lumps freshly mined, 50 per cent. for egg size, and 65 to 75 per cent. for egg size dried. These figures will be of interest later in connection with the tests of briquets.

The briquetting of lignite appears logically to go hand in hand with the generation of gas therefrom for the reason that this fuel has two essential constituents, a considerable quantity of gas that is driven off at a low temperature and a residue which burns slowly at a high temperature, so that in the interests of economy it is advisable to separate the two and burn each under the conditions best suited to it.

The experiments toward the generation of gas were first carried on on a laboratory scale and later in a larger plant such as would form a working unit on a commercial basis. The lignite is carbonized at from 1,200° F. to 1,400° F., and tar, ammonical liquors, etc., are removed, the gas scrubbed and purified. The products are gas, a residue high in fixed carbon, tar of prospective commercial value, and ammonia. An average of three runs showed a yield per ton of dried coal of 11,257 cubic feet of unpurified gas having a heat value of 402.2 B. T. U. per cubic foot and equivalent to 9,095 cubic feet of purified gas with heat value of 497.6 B. T. U. The yield of tar was 1 to 2 per cent.; of ammonia, as sulphate, 14.5 to 15 pounds per ton of dried lignite; and of retort residue 1,236 pounds.

The gas gives a light about equal to that of ordinary city gas but is lower in heat value, the average of the ordinary city gas being taken as 600 B. T. U. per cubic foot. In practice it was found that the purification of the gas was not necessary and that scrubbing with water alone would suffice and that the expense of purifying was not justified by the increased heat value of the gas.

The next step of the experimenters was to utilize the retort residue which was found to have a calorific value of from 10,500 to 11,500 B. T. U. Subsequent to the generation of gas the retort is discharged, the residue is sprayed to quench it and then ground to pass a 10-mesh screen. The experiments showed that the best results were obtained by briquetting the coal hot; so after the residue is crushed it is sent to a rotary cylinder in which it is heated by a fire of slack coal and sent hot to the briquetting press which, in this case, is of the rotary type. Four horsepower are required to produce 1 ton of briquets per hour.

Experiments toward producing briquets without a binder were not successful and experiments with different kinds of binders finally demonstrated the suitability of pitch mixed with small amounts of other substances such as flour, starch, gypsum, etc., the most satisfactory results being obtained with a binder of 5 to 6 per cent. pitch and 1 to 2 per cent. of fine ground screenings from grain. A ton of dried lignite furnishes, on an average, 1½ per cent. of pitch which is equal to about 2½ per cent. of the retort residue, so that it would be necessary to add about 3 per cent. pitch from other sources, but it has been found that the lignite pitch has certain qualities through which it may possibly be sold at a price that will equal the expense of supplying a cheaper pitch that will be equally satisfactory. The briquets so made were subjected

*Babcock, E. J., "Investigations of Lignite Coal Relative to the Production of Gas and Briquets," University of North Dakota, Grand Forks, N. Dak.

to such tests as would compare with the handling they would receive in shipping and use, and it was found that they withstood such tests in about the same manner as bituminous coal.

Of course the object of briquetting is to increase the heat value which has been done according to the following determinations:

Lignite as mined, 7,500 B. T. U.; retort residue, 11,000 B. T. U.; lignite briquets, 11,500 to 12,000 B. T. U.; anthracite, 12,000 to 13,000 B. T. U.

Following are some chemical analyses:

	Moisture	Volatile Matter	Fixed Carbon	Ash
Lignite as mined	35.01	25.11	34.67	5.21
Lignite briquets	0 to 6	2–8	75–85	10–14
Anthracite	3.68	5.26	80.51	10.55

The anthracite was a market sample and it will be noted that its analysis is almost identical with an average of the lignite briquets.

More interesting, however, is a series of comparative tests with anthracite similar to those described between the raw lignite and the bituminous coal. These tests, one of which is illustrated graphically in Fig. 3, show that, while the theoretical heat value of the anthracite is about 6 per cent. higher than that of the briquets, in a practical test the briquets have a heat value of 21 per cent. greater, based on evaporation, and 26 per cent. greater based on room temperature. The cause of this difference was evident when the ash was analyzed and it was found that that of the anthracite contained 43.5 per cent. unburned combustible matter while that of the lignite contained only 3.6 per cent.

While the above discussed experiments have demonstrated on a fairly large scale the feasibility of the manufacture of gas and briquets, no attempt has yet been made to apply the process commercially. Such conclusions as could be arrived at as to costs make it appear that, allowing that 2 tons of lignite as mined will be required to produce 1 ton of briquets, the briquets can be sold near the point of manufacture at a price considerably lower than that of Eastern bituminous coal and that they can be shipped a considerable distance and compete with anthracite.

The ideal application of the process would appear to be through a plant located at the pit mouth the gas from which would be used, either direct or through the medium of electricity, to furnish power for the mining operations and briquetting; any surplus to be sold in the form of electric energy, the retort residue to be briquetted and shipped in competition with the other coals of the state and the East.

Possibly this is looking too far into the future, but it hardly seems likely that these immense deposits are going to lie idle for long, when we consider that they are situated in the midst of a country which, during the past 5 years, has received such an influx of settlers as has

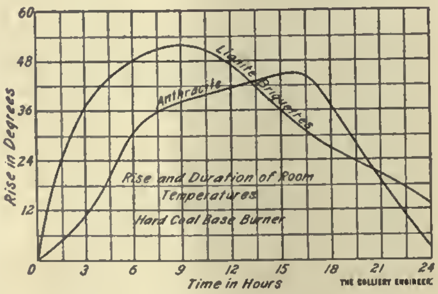


Fig. 3

rarely occurred outside of a mining boom, where natural resources are great and cheap power would be an invaluable aid to their development. It is reasonable to suppose that with the country a little more developed, so that the need for power is felt more keenly, methods of mining this lignite and using it at a reasonable cost will be perfected, probably along the lines discussed, and that Montana will take a place as one of the great coal producing states of the country.

Anthracite Miners' Earnings

With the coming of industrial peace in the anthracite region of Pennsylvania has come greater earning capacity to the miners as they are paid according to the amount of coal they produce.

When the breakers are not running it is useless for the miners to cut coal, so the way to arrive at an estimate of their earning capacity is to divide the annual output of the mines by the product of the number of miners employed and the number of breaker days. The result of this calculation, based on the figures in the last Report of the Bureau of Mines, is as follows:

Year	No. of Miners Employed	Average No. of Days Worked	Total Miners' Working Days	Output in Tons	Average Production Per Miner Per Day
1901	37,804	195	7,371,780	59,905,951	8.13
1902	36,392	116	4,221,472	36,911,549	8.74
1903	36,823	211	7,769,653	67,171,951	8.64
1904	39,848	213	8,487,624	65,709,258	7.74
1905	42,078	208	8,752,224	70,220,554	8.02
1906	41,801	206	8,611,006	64,410,277	7.48
1907	43,035	227	9,768,945	76,836,082	7.86
1908	44,340	211	9,355,740	74,592,181	7.97
1909	44,675	205	9,158,375	71,628,422	7.82
1910	43,651	212	9,254,012	74,717,852	8.07
1911	45,324	234	10,605,816	81,176,050	7.65
1912	44,696	220	9,833,120	84,426,869	8.58

Thus the miners are producing nearly as much coal per man per day as they were a decade ago when the beds were larger and the mining easier. Owing to the suspension in the summer of 1912 the number of working days that year was less than in the previous year. In spite of this, and the fact that fewer miners were employed, the production increased from 81,176,050 to 84,426,869 tons, and the average production per miner per day increased by nearly a ton. This implies an increase in efficiency of over 40,000 tons a day, and is a strong argument in favor of industrial peace which benefits employer and employe alike.—*P. & B.*

Mining engineers have calculated that the property of the Lingan Coal Co., in Nova Scotia, comprising 9 square miles, contains 40,000,000 tons of minable coal.

Ninety Minutes in a Boiler Room

How Wastes in a Boiler Plant May Be Detected By Use of Apparatus for Analyzing the Flue Gases

By F. W. Brady and C. J. Mason

As NO one can tell by looking at a horse kicking up how much he will pull, neither can any one interested in the operation of a steam boiler tell its efficiency simply by looking at it. What the fireman thinks his boilers are doing is likely not correct. It is easy to be fooled when guessing on the performance of a steam boiler. Generally, there are some unseen wastes that continue year after year, getting greater instead of less, while if they were discovered much of the loss could be prevented.

The operators of up-to-date boiler plants realize the uncertainty of the old-fashioned rule-of-thumb and guess-work methods, and they have adopted the mental-activity plan which depends on scientific tests and daily records that result in saving coal, increasing capacity, and giving greater plant economy. For this reason there have been numerous inventions of apparatus intended to indicate boiler-furnace efficiency. One of the most useful and practical of these is the gas analyzer which shows the amount of coal wasted in the gases that go up the stack. The instrument is arranged so that any fireman can use it quickly and thus save both coal and labor.

It is well known by mechanical engineers that with perfect combustion of the fuel used the carbon dioxide gas (CO_2) formed is 21 per cent. of the gases flowing into the stack, the remainder being nitrogen (N) that comes from the air used to burn the coal. With imperfect combustion the flue gases contain, in addition to the CO_2 and N, more or less carbon monoxide (CO), which is carbon incompletely burned, and generally some oxygen (O). It takes air for the combustion of coal, and either too much air or too little will cause a loss of heat. As the gases from a boiler furnace cannot be seen, it is impossible to know their composition without making an analysis. This analysis is made for the percentage of CO_2, O, and CO; but in most cases only that for CO_2 is necessary.

One of the small portable instruments used for making analyses of boiler-furnace gases is shown in Fig. 1. The working parts are protected by a metal case having hinged

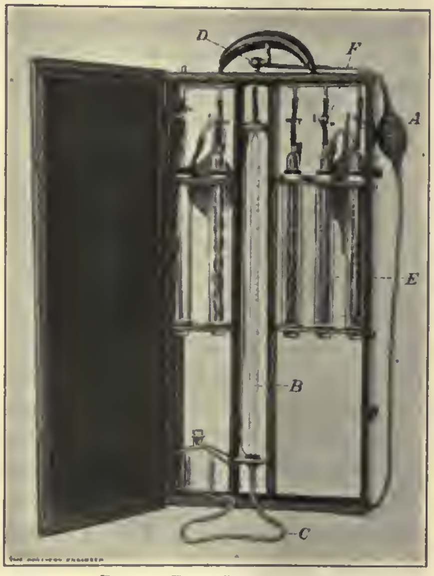


Fig. 1. Flue-Gas Analyzer

doors front and back which are opened to admit plenty of light when the instrument is in use. The hand operated bulb A has a long rubber tube which is attached to a 4-foot length of ¼-inch gas pipe, the latter being inserted into the gas flue of the boiler. By means of the bulb A the gas sample is pumped into the tall glass tube B. The leveling bottle C is filled with water and connected to the lower end of the tube B by a rubber tube. After closing the cock D to which the gas supply tube from A is attached, the bottle C is lifted from the case and raised until the water level stands at the zero mark on B. When the water in B and C stands at the same level, the gas sample in B is measured at atmospheric pressure. The glass tube E is filled with a solution of caustic potash which will absorb any CO_2 in the gases that may flow though it. The stop-cock F is opened and the bottle C raised until the water level rises to the top of B, thus forcing the measured flue gas sample through the potash solution in E where the CO_2 is absorbed. The bottle C is then lowered, allowing the water level to lower in B and the unabsorbed gas in E to flow back into B. The cock F is closed when the potash solution rises to the proper height in E, and the leveling bottle C is held at such a height that the water in B and C stands at the same level. The gas in B will then be measured at atmospheric pressure as before, and the reading of the scale on B gives the percentage of CO_2 in the sample. The testing of a sample requires but a few moments. Table 1 which is furnished with the analyzer gives the percentages of fuel losses, air excesses, and preventable losses for the different percentages of CO_2 in the furnace gases.

Table 1

Per Cent. of CO_2 in Furnace Gases	Air Excess Entering Furnace. Per Cent.	Fuel Loss. Per Cent.	Preventable Loss of Fuel. Per Cent.
15	38.0	12	0
14	47.8	13	1
13	59.2	14	2
12	72.5	15	3
11	88.1	16	4
10	107.0	18	6
9	130.0	20	8
8	158.7	23	11
7	195.7	26	14
6	245.0	30	18
5	314.0	36	24
4	417.0	40	33
3	590.0	60	48
2	935.0	90	78
1	1,970.0		

As an example showing the important discoveries that may be made in a few minutes with a gas analyzer, the following actual experience is related: With a gas analyzer under one arm we sauntered into the boiler room of the S. and H. Asylum and greeted the fireman, "Hello, Charlie, how are the boilers?"

"Fine as culm," he replied.

"Ever have any trouble keeping up steam?" we inquired, casually

glancing about the boiler room and mentally taking in its general condition.

"No," he continued affably, "we use two boilers, the steam blowers make plenty of draft, and we burn less coal than we did a year ago when we had the old played-out grates. I guess we're getting all out of the plant there's in it."

Fig. 2.

Evidently he believed what he said, and the outward condition of the plant did seem to verify his statement. Everything looked better than the average boiler plant. The steam gauges on the two 150-horsepower water-tube boilers stood at 110 pounds, no leaks were visible and the correct operation was indicated. Just then the fireman opened a furnace door and teased the fire, remarking that the firing was pretty steady work with washery culm and that the job would not be so hard if he did not have to shovel so much coal and ashes.

We drove a small nail into the wall of the boiler setting near the flue and hung the gas analyzer on it. Then we attached a 4-foot length of ¼-inch gas pipe to the rubber tube and passed the free end of the pipe through the peep hole, as at *A*, Fig. 2, into the path of the hot gases passing to the flue. In a few seconds a sample of the waste heat gases flowing to the chimney was pumped into the analyzer and the CO_2 found to be only 6 per cent. By referring to the table it will be seen that the presence of 6 per cent. of CO_2 in the flue gases means a preventable loss of 18 per cent. of the fuel. The table also shows that there is 245 per cent. excess of air going through the furnace, which indicates the cause of the trouble.

In about 2 minutes another sample was tested and 9 per cent. CO_2 found. This was better and the improvement was due to the coal last fired becoming incandescent. A third sample showed 4½ per cent., the fourth 8 per cent., the fifth 4½ per cent., and the sixth 3 per cent. The tests were continued for a few minutes and the percentages of CO_2 plotted on the chart from *A* to *B* as shown in Fig. 3. The average of CO_2 is 6.2 per cent., which means according to the table that there is a preventable loss of fuel of nearly 16 per cent. and that the furnace has about 245 per cent. excess of air. Surely, this was quite an item to discover in "a boiler plant that was as good as they could make it."

A close inspection of the boiler furnace showed the following facts: The fire was about 6 inches thick. There were several large holes through the fire at the back end of the grate. The presence of these holes was either not suspected or were considered of no importance. Then the surface of the fuel bed was very irregular and it was riddled with holes by the strong blast from the steam blower. The furnace doors were warped and open ¼ inch or more around the top and sides. Some additional air leaks were found around the minor boiler fittings. The large excess of air was cooling off the furnace and carrying the heat to the stack, a waste that had been going on for many months, and which was easily and quickly detected by the use of the gas analyzer.

After the fire was put in better shape by covering the entire grate, reducing the drafts from .3 inch of water to .1 inch, and making the fuel bed solid and level, a second test was made with the analyzer. The percentages of CO_2 from this test are plotted on the chart, Fig. 3, from *B* to *C* and show an average of 10.5 per cent. This means that by more careful firing the preventable loss was reduced from 16 per cent. to 5 per cent., the excess air being reduced about 145 per cent. Had the leaks around the doors and other of the boiler fittings been stopped up, probably as high as 15 per cent. of CO_2 could have been obtained, which is considered good practice.

One of the greatest mistakes a fireman makes is in supposing that no harm is caused by uncovered spots on the grate and by large air holes through the fire. The excess air which flows through these openings causes immense heat losses. Firemen more generally err in regulating the furnace air supply than in any other way. If the grate is

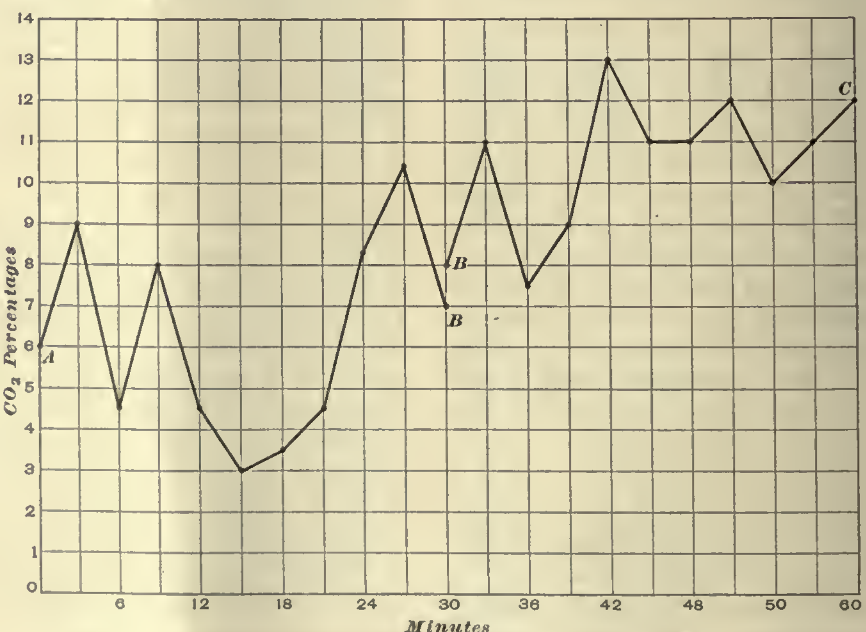


Fig. 3.

so long or wide as to make firing to the back wall difficult or impossible, rather than leave it uncovered with fuel it is better to cover this part of the grate with bricks and a thick bed of ashes.

A little figuring will show the fuel loss in this plant caused by allowing the firemen to guess at the furnace conditions. The grate surface of each boiler is 32 square feet. Three tons, or 6,000 pounds of coal were burned in 24 hours, or an average of 250 pounds per hour, approximately 8 pounds per square foot per hour. The coal used is known as No. 3 buckwheat, or washery culm, and costs $1.15 per ton delivered. It contains about 7 per cent. of moisture. The test with the gas analyzer showed that by the ordinary method of firing, handling the drafts, dampers, etc., there was a preventable loss of fuel of 16 per cent. This amounts to $6{,}000 \times .16 = 960$ pounds of coal, or $\frac{960}{2000} \times 1.15 = 55$ cents per day, $16.50 per month, or $198 per year that might be saved on each boiler. As three boilers were used during the winter months, the annual loss amounts to approximately $500. Besides the extra labor of handling the excess coal, extra ashes had to be handled. It would seem, therefore, that a little scientific testing would make it possible to save a large amount of muscular effort in this plant. The same condition has been found in nearly every plant tested.

It is common knowledge that leaving the furnace door open cools off the furnace and lowers the steam pressure. But keeping the doors closed does not always insure, as shown by the tests above, that no excess air is going through the furnace. The gas analyzer is sure to detect the loss and a search will then show the location of the defect.

It is important that a draft only strong enough to burn the grade of fuel used, and to keep the pressure of steam uniform, be employed. If a high-draft pressure is demanded, then the fire must be thicker than with a less draft. In no case should the draft be allowed to blow holes through fire. All firemen should be willing to learn how to fire a boiler with less coal per day, and if shown how to make the tests with a gas analyzer, they will not likely depart from good practice. Likewise the man who pays the bills should be willing to arrange the equipment so as to increase his profits.

Air Receiver Fires and Explosions

*By Frank Richards**

The following may satisfactorily answer the questions on "Oil in Air Receivers" asked in your Letter Box in July;

It is not possible with few words to dispose of all the matters suggested by the inquiry. One of the earliest and most persistent of air-compression troubles is that resulting from the use of lubricating oil in the cylinders. This oil cannot remain where it is functionally employed, but is carried away a little at a time by the compressed air, and it naturally accumulates in the receiver and the pipes.

Drawing off, or blowing off, the water in the receiver—and often there is very little water accumulating there—does not generally get rid of the oil, which clings to, and cakes on, the bottom and sides of the receiver and all along the pipes. This oil has been exposed to high temperature in the act of compression and generally all of it which could be volatilized at the highest temperature reached has been carried along by the air, and what remains is semisolid, black, and sticky.

The only way to get rid of it when once deposited must be by mechanical means such as actual scraping of the surfaces, so that air receivers would seem to require manholes rather more than steam boilers do, but it is not generally the fashion to provide them. By the way, if any one is to enter an air receiver for the purpose of scraping and cleaning it, the respirable condition of the air within should be assured.

*Editor of *Compressed Air.*

In the course of time, if oil is used "liberally" in the cylinders, and if nothing else is done about it, the accumulation of this gummy and highly combustible material may become quite thick, and then it becomes only a question of time as to when it will take fire. Such fires have been so frequent, and cases of air receivers becoming red hot, or nearly so, have been so numerous, that no one has thought it worth while to keep a record of them.

It is encouraging to note that while the number of compressed-air plants has increased beyond computation, the cases of air-receiver fires and explosions are apparently much less numerous than, say, a score of years ago, which shows that our practice has vastly improved, the pertinent details of which practice may appear as we go along.

As to what can cause the ignition of the oily deposit in the air receiver may seem quite puzzling at first, but there are ways to account for it. It may be thought, for instance, that the actual temperature reached in the single act of compression is not sufficient to cause it; but it certainly comes quite near it in some cases. Single-stage compressors in the olden time, say in the time of the building of the "new" Croton aqueduct, a little over a quarter of a century ago, were often worked up to 100-pound gauge, and the receiver fires were frequent.

Published tables assume, for convenience, the temperature of the intake air to be 60° F., and the temperature of the air when compressed to 100 pounds is 485 degrees. As a matter of fact, the air is heated more or less in entering the cylinder, so that when compression begins, even with intake air nominally at 60 degrees, the actual temperature of the air at the beginning of the compression is probably not less than 100 degrees, and then the terminal temperature after the compression would be 550 degrees.

In a case of which I had full personal knowledge, a portable oil-engine-driven air compressor was

working in the hot sun in the last week in June, entirely without shade or protection, and the receiver took fire internally and exploded. The interior of the receiver after the explosion (which was a simple pressure explosion, due to the fact that the receiver when so heated was not strong enough to stand the regular working pressure) showed the oil entirely burnt off the head, with every indication that it had been red hot.

In this case it is safe to assume that the air, hot to begin with and heated more in passing into the cylinder, was above 120 degrees at the beginning of the compression stroke, and that the temperature after the compression was at least 650 degrees. Certain oils will take fire spontaneously, and without the assistance of any igniting flame, at such temperatures as this, as is seen in the time-honored process of tempering steel springs by "blazing off" in oil.

I have been unable to find any authoritative tabulated statement of the temperatures of spontaneous ignition for the different oils, although it would be a comparatively simple matter to experimentally obtain the necessary data. We have the flash points and the burning points, but not the point here called for.

If spontaneous ignitions of oil can occur and do occur in the open atmosphere at temperatures which are reached or closely approximated in adiabatic single-stage compression, it is safe to expect that such ignitions should occur at lower temperatures when the compression concentrates six or eight times the quantity of air, and six or eight times the quantity of its oxygen constituent, at every point of contact with the oily deposit.

It is proper here also to suggest the possibilities of spontaneous ignition, at much lower temperatures than here spoken of, where oil is intimately mixed with other materials. I have seen the sweepings of a machine-shop floor collected in heaps to be picked up and carried away, and in half a day if neglected they would begin to smoke, while if left undisturbed for a whole working day and then stirred up they would show actual fire within, sometimes bursting into flame. Other illustrations in this line will readily suggest themselves.

We are not always quite as careful as we should be—often quite the reverse—about screening and guarding the air intake, and dust is often carried by the air in such quantities as to form a considerable aggregate. This dust collects and mingles more or less with oil which accumulates in the receiver and, not being disturbed when once deposited, the combination, if of the right materials, may easily generate heat sufficient to cause ignition independently of the heat due to the compression. To ignite the oil surface it is only necessary to have a firey glow and then a flame at a single point to have the fire immediately spread rapidly and burn fiercely if the compressor is running. Such fire must soon smother itself if the compressor ceases to supply and circulate fresh air.

If the conditions here suggested are permitted to exist, as leading to these ignitions of the oily deposit, the receiver should be strong enough to stand the working pressure even when thus heated by sudden internal combustion, and it may be said that generally air receivers are so strong that pressure explosions from this source are quite infrequent, as compared with the numbers of internal fires that occur. When a receiver fire is discovered, by the sudden heating of the receiver or otherwise, the compressor should be stopped at once to check the supply of fresh air.

When we are informed of the conditions causing or preceding these air-receiver fires it would seem to be a simple matter to avoid them. Stage compression should be insisted upon, with efficient intercooling and aftercooling. This would make the high temperatures impossible and would at the same time reduce the lubricant requirements. Some astonishing records have been made of minimum consumption of lubricating oil at Panama and elsewhere, and air-receiver fires have been unknown where these conditions have prevailed.

This is not all of the story about air-receiver explosions. There are two very different types of explosions, and one definition of the word does not satisfactorily cover them both. There is the explosion which takes place when the only pressure present is the regular gauge pressure, perhaps slightly increased for the time, but due entirely to the mechanical compression of the air, and when the receiver or the piping is at the moment not strong enough to withstand this pressure; and then there is a much more destructive explosion caused by a sudden and enormous increase of pressure caused by the ignition of an explosive mixture of some volatile constituents of the oil with the air. The pressures resulting from explosions of this character are comparable with those resulting from the explosions of gunpowder, and the results are correspondingly severe. It is especially for the avoidance of explosions of this type that it is recommended that the oil used shall have as high a flash point as possible, which means that the more volatile constituents of the oil shall have been already eliminated.

It is a fortunate circumstance that, to form a mixture which shall be destructively explosive, the proportions of air and of oil vapor must be within certain quite narrow limits. Thus in gasoline engine practice it has been found that the explosive range of mixture is between 2 and 5 per cent. of gasoline vapor and 98 to 95 per cent. of air. Nevertheless, such explosive mixtures do form in compressed-air receivers, or more frequently in the pipes leading from them, and such mixtures are sometimes ignited with explosive effect. The ignition may come from the receiver taking fire as previously explained and then the flames being carried along with the air until a point is reached where the explosion

proportions of mixture exist. However, it seems to be quite certain that if due precautions are taken to prevent accumulations of oily residue and dirt, and if high temperatures are avoided in compression, as economy itself would dictate, neither fires nor explosions will occur.

Approved Electric Safety Lamps

A Detailed Description of a Number of Electric Lamps That Have Been Approved for Use in English Coal Mines

THE types of approved electric safety lamps for English coal miners are specified in a recent order issued by the Home Secretary. The *Colliery Guardian* gives the following particulars of those now approved for general use:

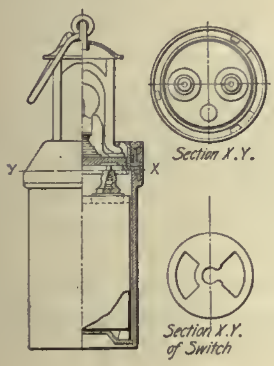


Fig. 1

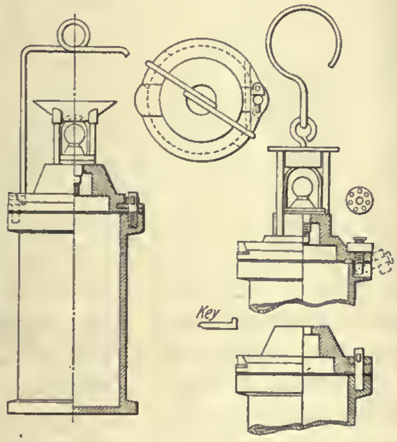


Fig. 2

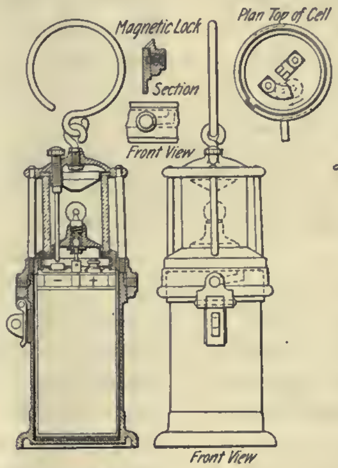


Fig. 3

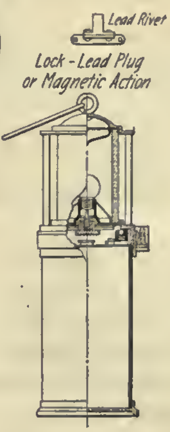


Fig. 4

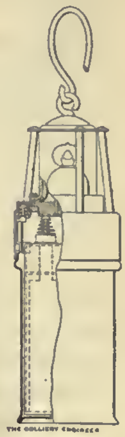


Fig. 5

The B. A. C. Lamp.—The B. A. C. miners' electric safety lamp, the general design of which is shown in Fig. 1, possesses the following essential features:

1. A battery case of stamped steel, with a securely welded or soldered steel or brass ring, slotted to form a bayonet joint with the cover.

2. A cover of stamped steel, with a vertical flanged rim, secured to the battery case by a bayonet joint and forming a flame-tight connection with the case.

The cover is fitted with an internal plate of vulcanized fiber, or other suitable insulating material, held in position by a brass screw ring. The plate carries the contacts, the bulb and reflector, and the outer protecting glass. The outer protecting glass forms a flame-tight connection with the cover by means of washers of india rubber or other suitable material.

3. The outer glass is protected by four steel pillars carrying a steel crown.

4. An electrical accumulator, so constructed as to prevent escape of the liquid, whatever the position of the lamp, whilst allowing the escape of gas generated by chemical action.

5. An efficient magnetic lock of the type shown in Fig. 1, so arranged that the bolt can be withdrawn only by means of a powerful electromagnet.

There are provisions that the total weight of the lamp is not more than 5½ pounds; that the strength of material and attachments throughout the lamp is not less than in the samples submitted for the official tests; that the lamp shall be capable of maintaining a light of not less than 1 candlepower all round in a horizontal plane throughout a period of not less than 9 hours, and also of giving light of not less than 1.5 candlepower over an arc of 45 degrees in a horizontal plane.

The Turquand-Kingsway Lamp. The Turquand-Kingsway miners' electric safety lamp, the general design of which is shown in Fig. 2, possesses the following essential features:

1. A battery case of steel, aluminum, or aluminum alloy.

2. A cover of steel aluminum, or aluminum alloy, making a flame-tight connection with the battery case by means of a washer of india rubber or other suitable material, and secured to the battery case by means of (*a*) a T-section steel stud engaging a slot in the cover lined with a steel bearing plate, (*b*) a lock of one of the types described in paragraph (5) below, and (*c*) two dowels entering holes in the cover.

3. A brass screw switch plate forming a flame-tight connection with the cover, and engaging a hollow screw lampholder carrying an insulated contact. The brass switch plate carries the protecting glass, which is kept in position by a lip, and forms a flame-tight joint with the brass plate by means of a washer of india rubber or other suitable material.

4. The protecting glass is supported at the top by a crown of steel, aluminum, or aluminum alloy, of one of the types shown in Fig. 2, supported by four steel pillars riveted to the crown, two at least of which are secured to the case by steel nuts on the inside of the cover, with which they make flame-tight connections.

5. An efficient locking device of one of the types shown in Fig. 2, consisting of

(*a*) A steel screw hinged to the battery case, provided with a milled-edge steel nut, perforated with holes corresponding with a hole in the cover; the nut is locked by a lead rivet when screwed home; or

(*b*) A steel pin secured to the battery case and fitted with a key-way. The pin passes through a hole in the cover and is locked by a steel key held in position by a lead rivet passing through holes in the key and cover.

The lamp, which is to weigh not more than 5½ pounds, is made at the works of the General Electric Co.

The Joel-Fors Lamp.—The Joel-Fors electric safety lamp, the general design of which is shown in Fig. 3, possesses the following essential features:

1. A cast aluminum-alloy battery case.

2. An electrical accumulator, so constructed as to prevent escape of the liquid whatever the position of the lamp, whilst allowing the escape of gas generated by chemical action in the accumulator.

3. A cast aluminum-alloy cover forming the base of the lantern cage and making a flame-tight connection with the battery case; the cover is secured to the case by means of a bayonet joint and a riveted hasp and staple, and is locked by a lead rivet lock or an efficient magnetic lock, of the types shown in Fig. 3.

The cover is fitted with a screwed castellated glass ring holding a stout protecting glass in position between the cover and a cast aluminum-alloy crown supported by steel pillars. The protecting glass forms flame-tight joints between the crown and the cover by means of asbestos or india rubber washers. A detachable bulb holder secured by a spring clip is mounted in the glass ring.

4. A flame-tight screw switch in the cover which can be brought into operation only when the cover is in the closed position.

The lamp, which is to weigh not more than 4½ pounds, is made at the works of John Mills & Sons.

Thomson-Rothwell Lamp.—The Thomson-Rothwell miners' electric safety lamp, the general design of which is shown in Fig. 4, possesses the following essential features:

1. A case of steel, brass, or aluminum, provided with a securely riveted or soldered flanged brass screwed locking ring.

2. An electrical accumulator, the terminals of which are fitted with spiral or other springs carrying rubbing brass contacts; the construction of the accumulator being such as to prevent escape of the liquid, whatever the position of the lamp, whilst allowing the escape of gas generated by chemical action.

3. A cover consisting of a middle base ring of brass or steel carrying an aluminum or steel crown supported by four or more brass or steel pillars.

The middle base ring is screw threaded internally to take a brass glass retaining plate. A stout protecting glass forms flame-tight connections with the crown and retaining plate by washers of asbestos or other suitable material. The glass retaining plate also carries the lamp holder and an insulated electrical contact piece. Provided that the cover forms a flame-tight connection with the case.

4. An efficient locking device of one or other of the following types, securing the cover to the case:

(*a*) A lead rivet lock of the type shown in Fig. 4.

(*b*) A magnetic lock of the type shown in Fig. 4, so constructed that the locking bolt can only be withdrawn by applying the pole of an electromagnet against the cover of the lock.

The lamp, which is to weigh not more than 5 pounds 4 ounces, is made at the works of J. H. Rothwell & Co.

Varta Miner's Lamp.—The Varta miner's electric safety lamp, the general design of which is shown in Fig. 5, possesses the following essential features:

1. A cylindrical, sheet-steel, seamless case which is stamped out in one piece, galvanized or enameled outside.

2. A stamped steel top which is secured to the cylindrical case by a flame-tight bayonet joint, and locked by a magnetic lock so constructed that the bolt can be withdrawn only by applying the pole of an electromagnet to the face of the lock.

3. A disk of insulating material within the lamp top carrying the bulb, reflector, and switch contacts. The disk is secured to the cover by a screw ring which bears on a flange on the disk.

4. A stout protecting well glass forming a flame-tight connection with the lamp top by a washer of india rubber or other suitable material.

5. The well glass is protected by a sheet-steel crown supported by five steel pillars riveted at both ends.

6. An electric accumulator so constructed as to prevent escape of the liquid whatever the position of the lamp, whilst allowing the escape of gas generated by chemical action, and fitted with sliding spring terminals.

The lamp, which is to weigh not more than 6½ pounds, is made at the works of the Varta Accumulatoren Gesellschaft.

Wolf Lamp No. 2.—The Wolf electric lamp No. 2, is a modification of the Wolf alkaline and lead lamps:

1. The general design of the lamp is shown in Fig. 6.

2. The case, of pressed steel, may be furnished or not with vertical ribs.

3. An alternative lock of the kind shown in Fig. 6 may be used, in which a spring bolt is held in position by a hinged cover secured by a lead rivet.

The lamp, which is to weigh not more than 5¼ pounds, is made at the works of the Wolf Safety Lamp Co.

ELECTRIC LAMPS FOR OFFICIALS

The following are electric safety lamps that have been approved for use by officials, or for special purposes only:

The Joel-Fors Inspectors Lamp. The Joel-Fors electric inspection lamp, the general design of which is shown in Fig. 7, possesses the following essential features:

1. A tinned or galvanized sheet-iron battery case with securely soldered or riveted joints, enameled internally and externally; fitted on the front with a tube through which passes the connection between the battery and the bulb. The tube enters, and is securely soldered to, the cup containing the bulb.

2. An electrical accumulator, so constructed as to prevent the escape of the liquid whatever the position of the lamp, whilst allowing the escape of gas generated by chemical action in the accumulator.

3. A fitted sheet-iron cap with securely soldered or riveted joints forming a flame-tight connection with the case and tube, and secured to the case by a riveted hasp and staple, and locked by a lead rivet lock.

4. A bulb secured by a screw to a reflector which is attached to and forms a flame-tight joint with a cylindrical cup, and encloses the lamp contacts; the cup is securely soldered or riveted to the battery case. The bulb is protected by a stout optical lens and holder, secured to the cup by a screw, and locked by a lead rivet lock.

5. A flame-tight screw switch in the cover, of one or other of the types shown in Figs. 7 and 8.

The lamp, which is to weigh not more than 2¼ pounds, is made at the works of John Mills & Sons.

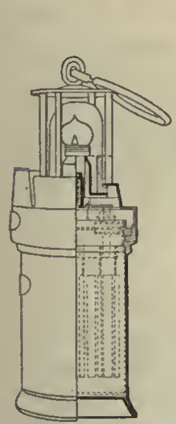


Fig. 6

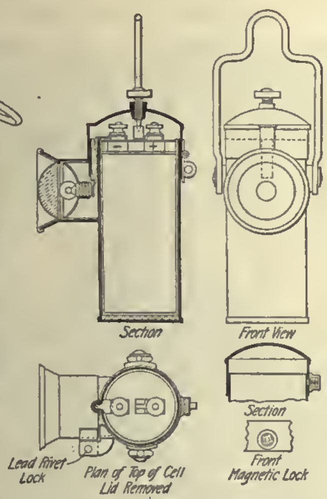


Fig. 7

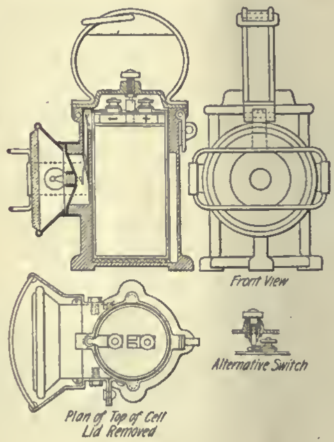


Fig. 8

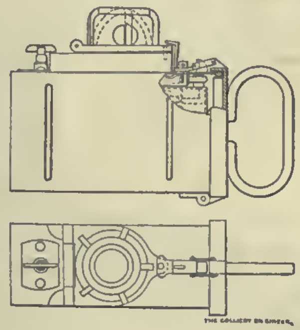


Fig. 9

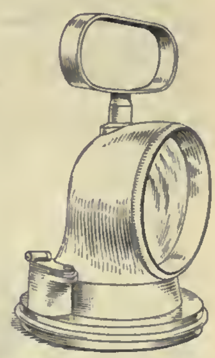


Fig. 10

The Joel-Fors Hand Lamp.—The Joel-Fors electric hand lamp, the general design of which is shown in Fig. 8, possesses the following essential features:

1. A cast aluminum-alloy battery case.

2. An electrical accumulator, so constructed as to prevent escape of the liquid whatever the position of the lamp, whilst allowing the escape of gas generated by chemical action in the accumulator.

3. A cast aluminum-alloy hinged cover, forming a flame-tight connection with the case, and secured thereto by a riveted hasp and staple, locked by a lead rivet lock.

4. A bulb secured by a screw to a reflector which is attached to the mouth of a cup-shaped recess on the front of the battery case and with which it forms a flame-tight connection enclosing the lamp contacts. The bulb is protected by a stout glass and holder secured to the battery case by screws.

5. A steel wire guard in front of the protecting glass, secured to the battery case by screws and locked by a lead rivet lock. The wire guard covers the screws securing the protecting glass holder, so that in order to remove the glass and holder the wire guard must first be removed.

6. A flame-tight screw switch in the cover, of either of the types shown in Fig. 8.

The lamp, which is to weigh not more than 4¾ pounds, is made at the works of John Mills & Sons.

Varta Inspectors Lamp.—The Varta electric safety lamp, the general design of which is shown in Fig. 9, possesses the following essential features:

1. A sheet-steel case stamped out of one piece, enameled outside; the front projecting piece, which contains the bulb, being of steel securely welded to the case, which has a steel lid hinged at the back and locked in front by a lever catch and a lead rivet lock. The lid forms a flame-tight connection with the case by the use of a washer of india rubber or other suitable material.

2. An electric accumulator so constructed as to prevent escape of the liquid whatever the position of the lamp, whilst allowing the escape of the gas generated by chemical action.

3. A block of insulating material within the case to which are fixed the contacts making connection with the battery terminals. The front of the block carries the bulb and a reflector.

4. A brass-hinged shield protecting and holding in position a stout protecting glass. The shield is secured by a screw at the top, which is covered by a projection on the locking lever, thus preventing the screw from being tampered with when the lamp is locked.

The protecting glass forms a flame-tight connection with the case

by means of a washer of india rubber or other suitable material.

5. A flame-tight screw switch on the front of the lamp held in position by a plate riveted to the case.

The lamp, which is to weigh not more than 7¾ pounds, is made at the works of the Varta Accumulatoren Gesellschaft.

The Wolf Rescue Lamp No. 2. This lamp is a modification of the Wolf electric lamp No. 2, and is identical with it in all but the following respects:

The bulb and reflector are contained in a hooded shield of the type shown in Fig. 10, furnished with a stout protecting glass held in position by a screw ring locked by a screw inserted from the inside of the cover.

The lamp, which is to weigh not more than 5¼ pounds, has been made at the works of the Wolf Safety Lamp Co.

Motors Using Gases from Coke Ovens*

The use of the gases from the coke ovens in gas engines is today general, and experiments are being conducted to increase the economy of their use.

As the gases escape from the engine cylinder at temperatures varying between 450° and 600° C. it seems logical to try to recuperate this heat by forcing the gases through a steam boiler placed on the exhaust pipe, thus furnishing hot water for the heating of the shops or for the use of the boilers, or producing directly steam under pressure used to put in motion the accessory machinery.

Several manufacturers, namely Cockerill, Nurnberg (Man), Ehrhardt & Sehmer, etc. have devised special types of boilers for this purpose, making it possible to obtain from the gas motor, for each horsepower hour, .8 kilogram of steam at a pressure of 8 kilograms; if this steam is used in a turbine requiring 7 kilograms per horsepower it corresponds to a supplementary yield of 10 horsepower for each 100 horsepower of the corresponding gas motor.

Another more recent improvement consists in applying to a group of four-cycle gas engines the principle of the removal of the product of the combustion, before introducing in the cylinder the new exploding mixture, in accordance with one of the fundamental principles of the two-cycle motors. Through this removal process the average pressure in the cylinder does not exceed the maximum of 5 kilograms per square centimeter, the security of the work is largely increased and important advantages are gained in the point of view of the thermic yield, on account of the improvement of the combustion and also on account of the cooling water not losing so much heat, since the cylinder's sides are less heated. Experiments made by Ehrhardt & Sehmer, in the shops at Skinninggrove (England), showed that a four-cycle, double-action motor, yielding 1,300 effective horsepower regularly, could give by applying the removal process 1,800 effective horsepower under normal conditions and as many as 2,000 horsepower under special conditions; the increase of power of the motor was, therefore, 38.5 per cent. The apparatus to apply the removal process has been put up by Ehrhardt & Sehmer in connection with the five gas motors of their plant having a total of 5,300 horsepower. It has been in operation since February 1, 1912, and other important appliances are in course of construction.

It is to be noted that the motors at Skinninggrove are using a gas of 1,200 to 1,300 calories per cubic meter, obtained by adding to gases from the blast furnaces of 900 calories, gases from the coke oven of 4,500 calories before passing through Theisen's purifier. This can be done easily without the use of gasometers. The same manufacturers have applied the removal process to two motors using gases from the blast furnaces and giving motion to continuous current dynamos at the steel works of Rœchling at Voelklingen-sur-Saar; the normal yield was brought from 1,318 to 2,140 kilowatts.

If boilers on the exhaust pipe of the gas engines are combined with the removal process applied to these same motors, as the steam generated is amply sufficient to work air and gas compressing turbines, it is reasonable to figure on an increase of about 10 per cent. on the power produced by a ton of coal.

*Translated from *L'Echo Des Mines* by A. Courtin, B. A. and B. S.

Explosion

An explosion of coal dust occurred at the Minister Achenbach colliery near Dortmund, December 18, 1912, in which 49 men were killed and three temporarily deprived of their reason, while 12 others developed mild cases of carbon monoxide poisoning. It happened in the western section of the No. 111 level of the southern field worked from shafts Nos. 1 and 11. The greatest damage was done at the lower end of the incline which led from No. 11 level to a lower one and was being extended at its lower end. The assumption as first made, that the explosion was caused by a shot irregularly fired to loosen some gob stuff which was being removed from the vicinity of the incline, appeared to be contradicted by the facts that at a point further to the west the body of a blast master was found with the fuses and other apparatus hung about him in position for firing, and that a blast had evidently just been fired by him when the explosion occurred. The dynamite in his possession (Neu-Nobelit 1) was of a relatively non-dangerous kind, and it remains a matter for conjecture whether he had used too large a quantity, or whether some other irregularity had occurred. The dynamite was subsequently tested in the experimenting section at Derne, where quantities up to 1.54 pounds were found not to explode coal dust and quantities up to 1.21 pounds were safe in inflammable gas.—*A. R. L. in Trans. I. M. E.*

Pembina Coal Co., Ltd.

A New and Modernly Equipped Coal Mine Operating in a Virgin Field in Alberta, Canada

By E. I. Roberts*

THE following description is interesting because the Pembina Coal Co. has endeavored to adopt modern methods of mining, and mine development in a virgin field.

It has been necessary to expend money on experimenting, for no method of working has as yet been established, and the labor for mining has to be trained.

Extra costs have therefore arisen even in prospecting work, and judgment has had to be shown in the choice of machinery and processes.

The physical conditions of the strata and seams were determined, and with these data the management decided to adopt the method of working the plant equipment here described.

The company is composed of English capitalists, with H. M. E. Evans, of Edmonton, president, and M. L. Hyde, general manager.

The property is divided into the east and west sections by the Pembina River, which flows in a deep gorge some 240 feet below the level of the railroads. It is 60 miles west of Edmonton on the Grand Trunk Pacific Railway, and 70 miles west on the Canadian Northern Railway.

The holdings comprise 5,000 acres in the eastern portion and 6,000 acres in the western portion, both surface and coal rights being held by the company.

It is proposed to work only 3 square miles of the western portion from the present shafts. This section is very rolling and to the north about 1 mile the Lobstick River crosses from west to east 140 feet above the No. 2 seam of coal, and about 200 feet below the mine site. In this river's course, several plateaus have been formed by the river receding to a deeper bed.

The location of the mine is on comparatively level ground where sufficient room for the miners' town and for future plant development is found. The Canadian Northern Railway passes the mine 400 feet to the north, and the Grand Trunk Pacific Railway, 1,800 feet to the south, both crossing from east to west.

The coal seams occur in the upper series of the Edmonton formation which is of the Cretaceous period, and are overlaid with shale beds and sandstones of the Paskapoo sedies.

Two seams only are proved at present, although there are marked indications of other seams at greater depth.

The No. 1 seam, approximately 22 feet 6 inches thick, is shown in section Fig. 2, is considerably broken with sulphur bands in addition to the clay partings. The analysis of the lower 6 feet 6 inches, which was considered the only workable section of the seam, is, moisture, 15.10 per cent.; volatile matter, 27.67 per cent.; fixed carbon, 47.23 per cent.; ash, 10 per cent.; total, 100. B. T. U., 9,504.

The No. 2 seam is 39 feet below the upper seam and is of much better quality. It is harder, has better roof and is free from sulphur intrusions. The section is shown in Fig. 2, and the analysis shows moisture, 9.10 per cent.; volatile matter, 30.20 per cent.; fixed carbon, 50 per cent.; ash, 10.70 per cent.; total, 100. B. T .U., 10,900.

Both coals are non-coking and are eminently suitable for domestic purposes, although the expense of cleaning and mining of the No. 1 seam is too great to render it profitable to work at the present time.

Fig. 1. Surface Works, Pembina Coal Co.

*Evansburgh, Alberta.

The prospecting, commenced on the east side of the Pembina River, consisted of drilling four holes at different places on the property. No. 1 seam was found in all bore holes, and the No. 2 seam in one only, the other holes not being past the No. 1 seam.

On the western portion, prospecting was commenced in May, 1910, and a 6′ x 8′ shaft sunk to the No. 1 seam near the Lobstick River. The nature of the overlying strata and of the coal seam was determined thereby, and from these data reports were made to the directors.

Included in these reports were several suggestions for developing the field, among which was the suggestion of the opening by a long slope, using the prospect shaft as an air-shaft; but this was abandoned in favor of the present shafts, owing to the extreme length of outside haul, expense of keeping the slope clear in winter, and the necessity of crossing the C. N. Railway for shipping on the Grand Trunk Pacific.

Until March, 1912, nothing was done outside of some further prospecting and topographical work. Supplies, however, were shipped in after March, 1912, for development work and preparations made for shaft sinking, which was commenced in September of the same year.

The hoisting shaft was sunk a distance of 80 feet before the air-shaft was started; after this both shafts were sunk simultaneously until completion.

Each shaft is 12 ft. x 18 ft. outside of the timbers. The hoisting shaft, containing two hoisting compartments and one pipe compartment, reaches the No. 1 seam at a depth of 221 feet and the No. 2 seam at a depth of 310 feet.

The air-shaft, which has one air compartment and one manway, is 320 feet deep to the No. 2 seam. Both shafts are securely lined the whole depth with 10″ x 10″ timbers and have water rings placed at the springs.

During shaft sinking, surface construction was rushed along and the machine shop and boilers were available for use shortly after the coal was reached.

The permanent head-gear was erected on a 2-foot shaft collar, around the temporary shaft sinking head-frame, and when completed the temporary structure was dismantled. The head-gear is of the usual wooden structure, 6-leg type

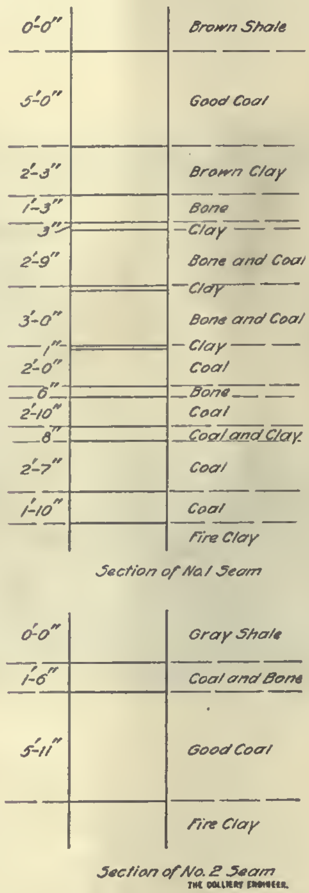


Fig. 2. Sections of Nos. 1 and 2 Seams

having two engine braces as shown in Fig. 1. It is built up of 4″ x 10″ planking with 4″ x 10″ braces and 10″ x 10″ side braces. It is surmounted by two 6-foot diameter sheave wheels set at a height of 65 feet above the top of shaft collar.

The 1½-ton cars used here are hoisted on two self-dumping cages, from which the cars discharge into a hopper feeding to a short length of 5-foot wide apron conveyer, which in turn feeds a 35-foot unbalanced shaker screen. The coal is sized into lump over 4-inch perforations; egg over 1½-inch perforations, and nut over ½-inch to ¾-inch slotted patent lip screen. The slack is taken from the shaker by means of a spiral conveyer, which delivers into a flight conveyer taking the coal to the boiler bins.

The apron conveyer, shaker screen, and spiral conveyer are driven by a 40-horsepower electric motor, and the flight conveyer by a 10-horsepower direct-current motor set over the bins, both motors being controlled by the topman.

The lump, egg, and nut coal are delivered to their respective picking tables by the shaker, and after picking, the coal is loaded into separate cars or passes into combining chutes so arranged that different varieties of product can be mixed. These picking tables are of the bar-scraper type and are driven by two 10-horsepower electric motors controlled by the picking table foreman.

The tipple is built of British Columbia fir and is tied into the head-frame; the shaker frame, however, is entirely separate. The rated capacity of this tipple is 1,000 tons in 8 hours.

Lump coal is loaded into box cars with a Christy box-car loader and the other sizes are loaded by hand.

All cars passing through the tipple are controlled by Fairmont retarders used on each separate track.

The railroad yards are so arranged that empty cars from both railways may be stored, and run into the storage yard on separate tracks. A run-around track for passage of locomotives from both railways is also provided. The cars run under the tipple by gravity, so that no auxiliary haulage is necessary except in severe winter weather.

All of the surface buildings are of wood, this being used during the experimental stage of the mine or until market conditions are proved.

The engine room shown in Fig. 4, contains a Litchfield 18″ x 36″ hoisting engine, equipped with a Welch overwinding device and two 6-foot drums keyed to the shaft. Pneumatic and electric signals are in use. That part of the engine room shown in Fig. 3 is equipped with a 200-kilowatt Allis-Chalmers turbogenerator and a 65-kilowatt Ideal engine

and belt-driven dynamo. Both are on a 250-volt circuit, having the necessary switchboards for electrical control and distribution to the mine, waterworks, surface, and townsite. The exhaust steam from these engines is used for heating the building and for heating boiler feedwater.

The machine shop is equipped with trip hammer, blacksmith forges, pipe-threading machine, power-driven hacksaw, lathe, emery wheel and grindstones, circular saw, punch, and shear. All power machines are driven through line shafting by a 10-horsepower electric motor. Cupboards, benches, and shelves are supplied for the use of machinists, blacksmiths, and electricians.

Partitioned off from machine shop is the warehouse, which is equipped with keeper's office, bins, shelves, storage platforms, etc., all stocked with a complete line of repair parts and fittings, supplies being issued through a small sliding door in the partition, and only upon receipt of written orders from the foremen.

The boiler house is built sufficiently large for four boilers, three of which are now installed. They are each 150 horsepower and of the return tubular type. A feedwater heater and pump for 600 horsepower is also in the boiler house. Extra large grates are under the boilers, so that the fine coal from the tipple can be used, and up to the present time this has been done without forced draft. The coal bins are of sufficient capacity for two days' supply and the ashes are removed in a steel car on a track in front of the boilers.

Adjoining the boiler house is a wash room, comfortably equipped with benches, six shower baths, wash troughs, and 100 hooks and chains with locks for hanging miner's clothes. The wash room is in care of the keeper who sleeps on the premises.

Water for the mine and townsite use is pumped from the Pembina River through a 4-inch wooden pipe into a 12,000-gallon tank, set on a 20-foot trestle. A three-stage centrifugal 200-gallon per minute electric-driven pump is used for this work.

The fan is set back from the airshaft 20 feet and equipped with explosion doors. It is a 14-foot diameter, direct-driven, Crawford & McCrimmon fan, capable of delivering 75,000 cubic feet of air against a 4-inch water gauge. Doors are so arranged that the direction of air-current can be reversed without stopping the fan.

Over the manway side of the No. 2 shaft, a 25-foot wooden head-gear is erected and this side of the shaft is equipped with a small cage for hoisting men and materials. An 8″ × 12″ second-motion hoisting engine is set in the hoisting house with all necessary indicators, signals, etc.

The material yard covers about 5 acres of ground and is situated along the line of the railroad yards, and a small narrow-gauge track with the necessary flat cars is used for taking supplies to the mine.

Thaw and powder houses are so situated that explosives are ready at all times to issue to miners, and they are placed also in such a position that in the event of the magazine exploding a minimum amount of damage will be done.

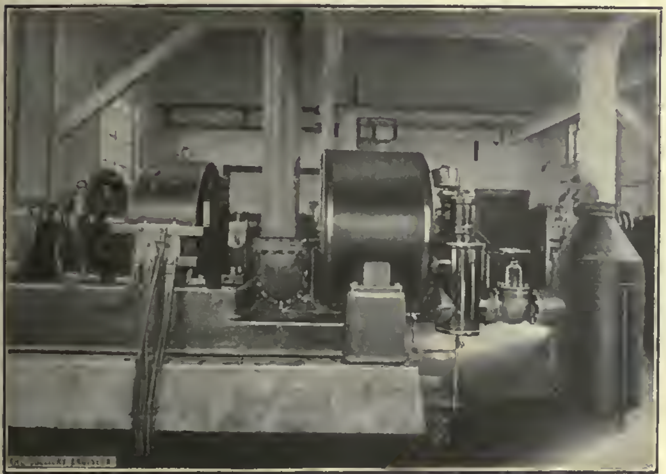


Fig. 3. Turbogenerator, Pembina Coal Co.

Fig. 4. Hoisting Engines, Pembina Coal Co.

The whole surface plant is fenced around and notices posted warning persons from entering buildings or yard.

The mine office is placed just outside of this fence and at present it is used for both the officials and the mine doctor. Engineering and drafting are done here and the doctor's portion of the office is equipped with sanitary appliances, ambulance, and first-aid equipment.

"Safety-First" signs are suitably placed and directions to employes posted. The required notices, plans, etc., under the Mines Act are conspicuously posted in frames outside of the mine office.

At the top of the shaft a check-board is placed and topmen are instructed to see that no unauthorized person enters the mine, or that no employe enters or leaves without placing on or taking off his check from the check-board.

The whole surface is properly lighted with electric clusters at

night, and fire fighting equipment stored ready for use. A night watchman makes periodic visits during the night.

The shaft bottom in the No. 1 seam was turned in a westerly direction, and the sump continued for 15 feet below No. 1 seam. The storage at the shaft bottom is 360 feet long and 20 feet wide. It is timbered with 10″ × 10″ timbers on 4-foot center lines, is lagged on three sides and whitewashed. Immediately at breaking away, the opening is beveled off, so that 30-foot lengths of rails can enter the seam. Sixty-pound steel rails are laid throughout this storage and a diamond cross-over is placed midway between the shaft bottom and branches to main entries. The grades are such that mechanical feeders can be installed to pull the cars to the cages and so feed the cages that the empties are pushed off and travel the run-around by gravity, where they are hauled up to their previous level by another feeder. Electric locomotives are used for delivering coal to this shaft bottom, each backing its trip to the feeders.

Fig. 5. Miners Houses, Pembina Coal Co.

It was the intention of the management to drive the main entries in the No. 1 seam to bisect the property in a north and south direction, but since the abandonment of this seam, this plan has been changed, and the No. 2 seam will be developed along these lines. At present entry work for the connecting of haulageways and for the construction of No. 2 shaft bottom is under way, and the No. 1 shaft is being extended down to the No. 2 seam, it being the intention of the company to work the No. 2 seam exclusively. Here 14 rooms are ready for working, the coal from which has hitherto been hoisted up a narrow prospecting tunnel, which had been driven to prove the quality of the seam. This naturally confines the work for the present to a small output, as the cars are hoisted by an electric hoist and the storage at both top and bottom is not large. The slope bottom is fed by a Jeffrey 6-ton gathering locomotive, and a Goodman 5-ton locomotive handles the output from the top of the slope into the No. 1 shaft bottom.

The panel being worked is divided into rooms driven on 50-foot centers. The rooms 20 feet wide are to be driven for a distance of 300 feet; all cars are hauled from the face with a crab on the locomotive.

The coal is undercut 6 feet by Sullivan and Jeffrey shortwall machines, each machine cutting on an average six places per 8-hour shift, including entries and cross-cuts. Breakthroughs are driven every 60 feet, and where necessary brattices extended to the face.

Electric power drills were at first used for boring the coal, but owing to the time lost in setting up and handling, the miners now use hand drills of the post type. When holes are drilled, the fire boss examines and issues detonators, the miner loading and tamping the hole and the fire boss doing the firing with an electric battery. One fire boss handles this section at present. The miners are paid on the level-full car basis for shooting, cleaning, loading, timbering, and tracklaying in the rooms. They also supply their own powder and caps. Carbide lights are used in rooms and safety lamps are used by the fire boss and the men driving entries. The rooms are timbered systematically with three rows of posts and cap pieces, set not farther apart in any direction than 6 feet, and the track is laid near one rib to facilitate the drawing of pillars; the waste is thrown in the opposite direction.

It is the intention of the management to open a section in the near future to try longwall working, as all indications show this seam to be a good proposition for this system. The roof has hitherto proven rather tough and solid, owing to the 19 inches of coal and bone which is left up, and so far as the workings have gone there has been no signs of the bottom heaving.

All of the most important switches, stations, crossings, and room necks are electrically lighted and manholes are placed in the haulage way for safety.

Water from both shafts is pumped to the surface with a three-stage centrifugal, electrically driven pump, a duplicate of the river pump. Steam pumps are also installed as auxiliaries. The workings are drained with a small portable electric pump mounted on a truck. The majority of the places, however, are dry.

Fifty steel cars are in use that have solid wheels and axles turning in bronze bearings. Twenty-five wooden cars are being replaced by steel cars as rapidly as possible. Haulageways are equipped with 30-pound steel rails laid on 5-inch ties, and rooms have 25-pound steel rails on 4-inch ties; all trackwork being securely fishplated.

Entries are driven on 50-foot centers and with the machine an advance of 6 feet per shift per entry

has been attained, this includes laying track and three-stick timbering on 5-foot centers.

Telephonic communication is established between the mine office and the most important places on the surface and underground, so that officials are in touch at all times with the workmen and the working of the mine. The pneumatic signals also afford a further means of communication between the hoisting engineer, topman, and cagers.

"Safety-First" signs, instructions for resuscitation after electric shock, and for fighting fires are posted in the most conspicuous places underground.

On the townsite there are 24 four-roomed bungalows of the distinctive design shown in Fig. 5, each being painted differently and of slightly different shape. These houses are plastered inside and are generally cosy. Electric lights are supplied at a nominal figure and water is supplied to hydrants for every two houses. Each house is situated on its own lot and the company plows up and furnishes seed for the planting of gardens. Several six-room houses will be built this year, and also a hotel, store, and men's club house will be constructed in the near future.

At present one of the old construction log buildings is used as a club house. It is equipped with billiard and pool tables, reading tables and reading matter, barber chair, and one of the rooms was used during the winter for classes, the management teaching elementary mining, mathematics, and drawing, and the doctor teaching first aid.

Another construction building is used for the company's store, which is usually stocked with a complete line of dry goods, groceries, and hardware. A coupon system is in vogue for the convenience of employes.

A general office is within reasonable distance of the mine and all sales, shipments, pay roll, and head office work is handled there.

Sales agents are appointed at the most important centers in Alberta, Saskatchewan, and British Columbia, and traveling agents keep the mine thoroughly in touch with the coal market. As this is a domestic coal, climatic conditions cause a great deal of fluctuation between the summer and winter months, so that for a large portion of the year the mine does not run to its full output.

Good brick making clay has been found within a mile of the mine and the company is now considering the erection of a brick plant to consume the majority of the small sizes of the coal and insure a minimum loss from waste.

Driving Weston Colliery Tunnel

By Stephen W. Symons

Although presenting a problem not dissimilar to any number of other such tunnels, the "entry tunnel" which was recently driven for the Locust Mountain Coal Co., of Shenandoah, Pa., and the methods by which the work was prosecuted, are of interest to coal operators and tunnel contractors by reason of the remarkably consistent and fast progress which prevailed.

The size of tunnel was 7 ft. × 12 ft. with a drainage ditch 4 ft. × 2 ft. at the right-hand side. It was driven through a hard conglomerate, with the exception of 450 feet through red shale carrying a small quantity of water. The total driven length was 3,689 feet, 3 feet less than the estimated distance.

Two Imperial air compressors belted to General Electric motors supplied the air for the drills. These machines compress 560 cubic feet of air to 110 pounds at the receiver, giving 105 pounds at the drills; only one machine was in use at a time. An attempt was made to lower the pressure in order to reduce the strain on the drills, but this was abandoned owing to complaints from the drill runners who noticed the change immediately and claimed, that owing to the hardness of the rock, the drilling speed was reduced.

Two Leyner-Ingersoll drills were used on a 7-foot horizontal bar and a third kept in reserve. One "Butterfly" stoper and one Jackhamer were used for trimming and ditch work.

Water was supplied to the drills by a direct acting Cameron pump operated by air and shown in Fig. 1. This pumped the water from the drainage ditch into the tank shown on the right and air was turned on to keep it at an even pressure at the drills.

All steel was sharpened by an air-driven Leyner sharpener. The blacksmith shop equipment included a coke forge.

Ventilation was furnished by a pressure fan driven by a General Electric motor. This was placed at the entrance to the tunnel and the air forced through a 20-inch galvanized iron pipe. Air for the drills was carried through a 3-inch pipe ending in a manifold.

For handling the muck, six 1-yard side-dump cars were used, drawn by an electric storage-battery locomotive. Track of 24-inch gauge was used and a false track kept well up to the face.

Three shifts per day were employed. Each crew averaged 6 hours at the face, from the time the crew entered until the round was completely drilled.

Each shift consisted of 1 shift boss, 4 machine men, 6 muckers, 1 motor man, 1 brakeman, 1 ditch and floor walker, and 1 man to dump the muck.

The three-shift method of driving was found feasible by employing high-speed drills of the self-rotating hammer type, and by the adoption of a comparatively shallow cut, approximately 5½ feet per shot, although the drill holes averaged 6 feet deep. This is in line with the most modern practice in tunnel driving, it being found that a slight decrease in depth of cut with a larger number of comparatively small holes, carefully placed, permits employing more shifts in a given time and a considerable increase in speed of driving. Though

no attempt was made at record breaking, a remarkably uniform yet fast speed was maintained over the whole period of driving. The average rate accomplished was 15.66 feet per day.

Considering the extreme hardness of the rock, this compares very favorably with such tunnels as the Laramie Poudre, the Montreal, and the Loetschberg (the two last named were driven through soft limestone).

The best month's progress was during October, 1913, when 513 feet were driven in 28 working days.

The drilling round varied considerably, being changed according to the nature of the ground. In general, the system followed was that known as the "Leyner cut," shown in Fig. 2, in which 18 to 24 holes were drilled. The average time for drilling the round was 5 hours, Hercules blasting gelatine of which 77,975 pounds of 60 per cent. and 3,150 pounds of 50 per cent. with a small quantity of 40 per cent. and 100 per cent. was used. The shots were fired by fuse, cut to such lengths that the holes would fire in the order desired, the cut holes being the first to break. A total of 164,250 feet of Crescent fuse, and 20,023 No. 8 caps was used.

In general, the muckers were able to enter the tunnel 15 minutes after shooting; this was made possible by the efficient system of ventilation assisted by turning on full air pressure from the compressors immediately after shooting. In from 15 to 30 minutes the muck pile was sufficiently reduced to allow operating the drills from the top set-up. Here the advantages of the tunnel bar over the usual column is clearly shown. All holes but the three lifters were drilled from the upper set-up of the bar and as a rule the heading was completely mucked out by the time the drilling crew were ready to put in the lifters. The bar was then changed to the lower set-up and the three lift holes drilled, this operation taking between 15 and 30 minutes. The right-hand lift hole was drilled deep and low to form the ditch. The commendatory feature about the system was the prosecution of the drilling and mucking operations with the minimum loss of time for both drill runners and muckers.

The drills used embodied in their design a water feed attachment, which entirely eliminated the dust, the heading being remarkably clear except for a slight fog from the drill exhaust.

The tunnel was finished with ditch taken up and road to line and grade as the work progressed.

The use of a tunnel through the side of the mountain places all the coal in the vein, which is known as the Little Buck Mountain, above water level and allows economical transportation to the breaker as well as efficient drainage. The Little Buck Mountain bed is to be mined from the tunnel and the overlying veins by open cut and stripping methods. In all, the Locust Mountain Coal Co. expects to produce 1,000 to 2,000 tons daily.

The writer is personally indebted to Mr. Hugh Dolan, of Dolan Bros., of Pottsville, Pa., for the data herein contained and for assistance in procuring photographs.

Fig. 1. Weston Colliery Tunnel, Looking Towards Portal

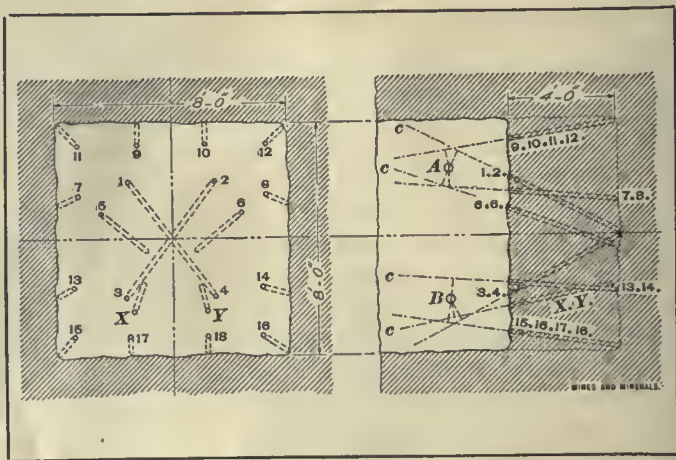


Fig. 2. The Leyner Cut

Timber Preservation in 1913

The most notable progress yet recorded in the chemical treatment of timber to prevent decay was made in 1913, according to a report recently issued by the American Wood Preservers' Association in cooperation with the Forest Service of the Department of Agriculture.

The report states that 93 wood preserving plants in 1913 consumed over 108 million gallons of creosote oil, 26 million pounds of dry zinc chloride, and nearly four million gallons of other liquid preservatives. With these the plants treated over 153 million cubic feet of timber, or about 23 per cent. more than in 1912. The output from additional plants unrecorded would increase the totals given.

Real progress in the United States dates from 1832, when the Kyanizing process, using bichlorides of mercury, was developed. In 1837, two other processes were introduced, the Burnett process using zinc chloride, and the Bethel process using coal tar creosote.

WITH THE EDITORS

A Surfeit of Mine Legislation?

IT IS a well-known fact that the prevailing belief in mining circles, is that there is a surfeit of mining legislation and that if the various state legislatures would ignore mines and mining for several years, something tangible might be ultimately accomplished.

At the recent banquet of the State Mine Inspectors at Pittsburg, Mr. W. H. Fohl, a mining engineer, in speaking of this sentiment said it was a mistaken idea in so far as it pertained to the business of mining coal. He suggested a method of eradicating present evils by a combination of ideas, that is by the enactment of a standard mine law representing the most advanced methods, from a standpoint of safety and economy now existing in the various states.

The suggestion is highly praiseworthy, and no group of men would endorse such a law more heartily than the mine operators affected, who would look forward to such a condition of affairs as a veritable Utopia.

Still we do not believe a uniform law could bring about this condition because natural advantages enter more into the cost of production than safety measures, but neglecting this difference of opinion there are excellent reasons why a uniform mine law should exist in all states. Mr. Fohl stated that the present mine laws were tri-party agreements between mine owners, miners, and state mine inspectors, that there were too many laws and yet not enough of the right sort. We thoroughly agree in this statement, as must others who notice the numerous changes made in the various state laws, with representatives of the miners introducing bills entirely at variance with the object of mine laws, and representatives of the operators opposing them, while the inspectors must stand to one side, since their positions in most instances depend on their passivity in matters of this kind. The first mine safety laws in this country were enacted not on the demands of the miners or the operators, but by the people, who were aroused into action by the Avondale disaster. We have had coal mine legislation and inspectors since 1870, yet a mine code satisfactory to all has not been enacted because the intent of the law is made a side issue to things mercantile.

Our mine laws are police regulations to preserve the health, lives, and limbs of miners, for anything injurious to them is against public policy. A committee appointed by the American Mining Congress formulated a uniform mine code. The Mining and Metallurgical Society of America has also drawn up a similar code, yet it is doubtful if any one state could be induced to adopt them although they are fair to all sides concerned. Why? Because the labor agitators, who say they represent the miners, would oppose them because they could not make political capital out of such legislation and consequently would lose prestige in the eyes of their constituents.

The operators would not oppose the code for they are strictly in line with the "Safety First" movement, and most operators today are exceeding the regulations specified in the present mine laws by adopting measures that tend to greater safety of the mine workers. Recently it was suggested by Chief Roderick, of the Pennsylvania Department of Mines, that the companies employ inspectors to be on the watch throughout the mine during working hours, as a means to decrease accidents, yet some miners threatened to strike if they were not removed. In another place the men are demanding the removal of Safety-First signs calling attention to danger.

When the primal object of mine laws is strictly adhered to, there will be no objections offered to their passage by the operators, but when class legislation such as scale and wage issues is attempted they must necessarily protest.

Lawyers in the legislatures would oppose a uniform mine law because it would state in clear and precise terms its object and not be clouded with indefinite verbiage affording opportunities for lawsuits. It is only recently that Chief Roderick had to request the legal department to render a decision on what a passage in the new bituminous law really did mean.

We are of the opinion that "police laws," that is, safety laws enacted for the health and safety of mine workers will not prove to be factors in the cost of coal production, but we know that when class legislation of the socialistic kinds is passed in any of the states, particularly like the recent Ohio law, it will not only increase the cost, but cause dissatisfaction and constant bickering, and a resumé of past experiences shows we have had enough of that brand of politics.

Company Mine Inspectors

FOR quite a number of years some bituminous coal operators in various parts of the country have hired company inspectors in the hope of reducing accidents in mines. As a rule the system has been a success, and it is urged by the Inspectors of Illinois that for every so many mine workers there shall be a "face boss."

The men employed in mines where there are company inspectors should use every endeavor to aid them

in bringing about the much hoped-for decrease in mining accidents, because the system is not only expensive but it is for the mutual benefit of the men and company.

The results obtained by making use of company inspectors have been so satisfying in other states that Chief of Pennsylvania Bureau of Mines, James E. Roderick, suggested to the anthracite operators that they adopt the system. Colonel Phillips, Manager of the Coal Department of the D., L. & W. Co., has been trying it out with the following result, that a strike was threatened if the "patrol system" as the miners call it was not removed.

This inspection causes a large voluntary additional expense to the company and in no locality on earth is it more needed than in the anthracite districts, because of the large number of men killed and a greater number maimed or broken for life. A good miner will produce 1,500 tons of coal in a year; but in 1911 there were 626 killed underground and if all were miners it means a loss of 2,817,000 tons, which would supply a large community and keep them in comfort during the winter, thus society was a loser.

Most of this number of men were married and left wives and children who must get along as best they can, and here again society was the loser. A large number of lawsuits originated from these accidents and here the company loses. No matter how capable a miner may be, he is not permitted to work in an anthracite mine without working 2 years as a laborer. To the anthracite companies this means that if a laborer commences work when a miner is killed there is a loss of production, based on 1911 figures, of 5,634,000 tons of coal. From an economic standpoint, prevention of accidents in mines is as important to society as to the coal companies and in no way can this be brought about better than by company inspectors. Chief Roderick states in his 1912 report that 64.66 per cent. of the fatal accidents in anthracite mines were due to carelessness of the killed; 6.43 per cent. due to the carelessness of others; and 28.91 per cent. were unavoidable.

Recently a mine inspector stated that if a man was discharged for carelessness or infraction of the rules, the miners would strike at that colliery. If such conditions as these prevail it is more than likely that society wants them to strike and stay struck forever.

Early Anthracite Mining

THE mining and preparation of anthracite was done in a very primitive manner, until shortly before the outbreak of the civil war, when some few slightly improved methods came in vogue. Just about the time improvements began John Hale, a young man of superior natural intelligence, of English parentage, but raised in the coal fields of Wales, came to America and settled in Hyde Park, now the western portion of the city of Scranton. Mr. Hale, a remarkably well-preserved man, both mentally and physically, recently celebrated his eighty-second birthday. He came to this country in 1856, and in 1857 secured employment as a miner at the Bellevue colliery, still in operation by the Lackawanna Coal Co. On March 15, 1869, he was promoted to the position of mine foreman at the same mine, and he filled this position until 1903, when he was retired on a pension, being the first man put on the pension list by the D., L. & W. Co.

As Mr. Hale had a personal experience of 46 years in anthracite mining and for the past 11 years has kept himself informed in mining progress, the editor asked him to give some brief reminiscences of early anthracite mining. This he has done, and his article appears on another page of this issue. It will be found very interesting to both old and young readers.

Besides his skill as a miner and his remarkably successful record as foreman of a great anthracite mine, Mr. Hale has won distinction as the inventor or maker of no less than sixteen instruments of precision, all of which, including a mining transit, he has made with his own hands, and he also designed and constructed the machinery with which he made them, including a graduating machine of great accuracy.

In his attractive and comfortable home on South Main Avenue, Scranton, he has installed a work room well worth a visit, in which, when the spirit moves him, he indulges in his taste for fine mechanics and scientific experiments. Aside from his mining work, he never gave much attention to other business.

Many of his inventions are not patented, but these, as well as those he patented, embody original valuable ideas which commend them to many users. If Mr. Hale was a younger man and was so situated financially as to require his exerting himself in business, he would have an excellent opportunity for success through his inventions.

Political Buncombe

THERE are three prominent candidates for the position of United States Senator from Pennsylvania, viz.: Boies Penrose, Mitchell Palmer, and Gifford Pinchot. In the triangular political contest, this journal is, as should be the case with a purely technical publication, entirely independent. It does not support or oppose the platforms of any of the three parties, but it always has and always will denounce statements made by political officials or candidates, who to further their own ends, directly or indirectly make misstatements regarding the coal industry. During the past month, Mr. Pinchot, in making a campaign tour through the Wyoming Valley of Pennsylvania, in at least one of his speeches said:

"Eighty-seven per cent. of all of the coal in this country is owned or controlled by about 40 rich men, and they are able to regulate the prices charged for it, making you pay just what they please for it. Listen: what do you miners get per ton for mining coal?"

"Fifty-nine cents," called back some one in the crowd.

"Fifty-nine cents, and you have to pay your laborer out of that. And what do you householders have to pay for a ton of coal?"

Various answers came back; Pinchot finally accepted $4.25 a ton—$4.75 hauled—as the price for stove coal, and went on.

"You miners get 59 cents for mining that ton of coal and you householders pay $4.75 when you purchase it. Who gets the difference? I'll tell you. These rich corporations; they are the ones who are getting four or five profits on coal. Here is what we intend to do. The Washington Party proposes to get right at the heart of the question and cut down the price of coal to the consumer. It proposes further, to see that the miner is paid more and that his labor is safer."

Whether in making this statement Mr. Pinchot was guilty of refraining from telling the whole truth, and thereby creating an outrageously false impression in the minds of some of the workingmen in the anthracite regions who do not, or who will not, understand all the items that enter into mining costs, as well as in the minds of uninformed citizens in other sections of the state, or whether it was simply a display of gross ignorance, we do not know.

We do know, however, that if the remarks were made through ignorance, the author of them is certainly not well enough versed in Pennsylvania's greatest industry —coal mining—to make him a safe man to represent the state in the United States Senate.

If, on the other hand, Mr. Pinchot knows better, then he is guilty of cheap demagoguery, and his attack on the industry should be resented by every intelligent man either directly or indirectly connected with it.

Attacks on "Big Business"

It doesn't matter what the business is, or how honorably and carefully it is conducted, if it is "big business" it is the target for abuse and misrepresentation from a class of writers who have in the past few years caused greater monetary loss to the United States than the amount expended by the nation during the Spanish-American war.

That some large combinations of capital have transgressed the law is admitted, but it is as unjust to say they all do, as it is to blame all men connected with labor organizations for the acts of those of the officials of the Structural Iron Workers Union who were recently convicted of dynamite outrages.

But, "envy and malice love a shining mark" and when those qualities in a writer are encouraged by a few dollars, paid by a periodical, no corporation or industry is immune from attacks.

Harper's Weekly, usually conservative and clean, recently published a couple of articles by Charles Johnson Post, attacking the Du Pont Powder Co. in connection with its dealings with the United States Government. When the officials of the Du Pont Company called the attention of the editor to the misstatements made, opportunity was quickly given for the company to refute them. In the issue of *Harper's Weekly* for June 27, Mr. E. G. Buckner, vice-president of the Du Pont Powder Co., in a page article, by a publication of facts, refutes every inference or conclusion reflecting on his company. Mr. Buckner's statement is clear, concise and backed up by records, dates, and references that cannot be disputed.

In his articles, Mr. Post, by inference at least, accused the Du Pont company of treason. Those who know the history of the company and of the United States know that there never was a more patriotic business institution than the Du Pont company, and its products were on many occasions of more than ordinary value and service to the Government.

Cinderella Mine Fire

The following information is furnished by George S. Patterson, secretary of the Sycamore Coal Co., of West Virginia, whose mine at Cinderella recently caught fire.

The mine is located about 4 miles from Williamson, in Mingo County, W. Va. At this colliery there are two beds of coal, the Winifrede seam, which is about 500 feet above creek level and the Coalburg seam, which is about 55 feet above the Winifrede. The Winifrede bed is from 4 to 5½ feet thick and the Coalburg bed is about 4½ feet. Five openings are on the line of the Winifrede seam, No. 1 opening being driven through the mountain, a distance of about 700 feet. This opening is supplied with one blowing fan which furnishes air to this entry and also to No. 1 entry into the upper seam. The air being carried to the latter through a wooden air box 6 feet square, by 100 feet long. The fan is driven by an electric motor.

No. 1 opening in the upper seam is directly over No. 1 opening in the lower seam and was also driven through the hill, having two openings on the farther side. The coal from the upper seam is let down to the lower by tram roads.

On the night of the accident three machine men and two shot firers were working in the upper seam. The mine night boss and machine boss visited them; one of the men came out for oil and returned to the other men. The night boss passed close to the fan, in going from the mine to the mine office, and in less than 10 minutes afterwards he saw a blaze coming out of the wooden air box and immediately tried to get into the fan house and stop the fan. Being unable to do this he tried to go into the mine, but the smoke was so thick, it was impossible for him to proceed. The five men mentioned, who lost their lives, were working in the mine on the return air. When the rescuers got to the mouths of the drifts, it was impossible to get into the mines on

account of the smoke which they found there.

A small disc fan was then moved from another place and set up in one of the drifts to drive the air out of the mines in the hope that possibly in some way they could get to the men inside.

In addition to this a point was located on the outcrop of the seam and a large number of men put to work to drive a hole through to the face of the entry. This hole was started about 4:30 A. M. and the opening was made about 2:00 P. M. when a party entered the mine and found all the men dead. They did not appear to have moved from their places of work and evidently had been overcome soon after the fire started.

Old Freibergers

On June 13, the Old Freibergers in America met in New York City, in honor of Dr. Friedrich Kolbeck, Rektor of the Freiberg Bergakademie, Saxony, Germany. Doctor Kolbeck came to this country to represent the Royal Mining School at the fiftieth anniversary of the School of Mines, of Columbia University, New York City. Dr. R. W. Raymond made an excellent address in German. Mr. Franklin Guiterman and Mr. F. G. Corning gave the members a great treat when called upon to give a toast, and Dr. P. J. Oettinger (Freiberg, 1865) told many interesting reminiscences. Doctor Kolbeck's speech was very interesting.

He recalled some of the men of Freiberg who have advanced the arts of mining and metallurgy and are known the world over. Among those mentioned by Doctor Kolbeck were Dr. R. W. Raymond, Dr. S. F. Emmons, John Hays Hammond, F. G. Corning, Franklin Guiterman, Dr. Edward Peters, and Prof. Waldemar Lindgren. Doctor Kolbeck said that he hoped to see a number of former students of Freiberg back to celebrate the one hundred fiftieth anniversary of the Bergakademie in 1916.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Geological Section

Editor The Colliery Engineer:

SIR:—Question 234 in the book entitled "Examination Questions for Certificates of Competency in Coal Mining" reads as follows:

"Draw a geological section from north to south through an anthracite field at any point with which you are familiar."

Would you kindly insert in your next issue such a section through Pittston?

OLD READER

Plainfield, Pa.

Simply draw a columnar section showing the seams of the northern field from Nanticoke to Carbondale which, reading down, are as follows: Snake Island, Abbott, Bowkley or Lance, Hillman, Five-Foot or Checker, Upper Baltimore or Cooper, Lower Baltimore or Bennett, Marcy or Skidmore, Ross or Clarke, and Red Ash.

Ventilation

Editor The Colliery Engineer:

SIR:—We would appreciate an answer to the following problem:

A given power circulates 75,000 cubic feet of air per minute through a certain airway, in a continuous current, and it is decided to divide the air into three splits as follows:

Split A, 6 ft. × 6 ft. × 5,000 ft. long.
Split B, 5 ft. × 6 ft. × 4,500 ft. long.
Split C, 6 ft. × 7 ft. × 4,000 ft. long.

Calculate the quantity of air that will pass in each split, assuming that the power on the air remains unchanged.

FRED VINTON

Heilwood, Pa.

First calculate the respective potentials with respect to pressure.

We have the formula, $x_p = a\sqrt{\frac{a}{ks}}$

x_p = pressure potential;
k = coefficient of friction;
s = length of the airway multiplied by its perimeter.

Now k is constant for all the splits, so it may be neglected

For the split A,

$$x_1 = 36\sqrt{\frac{36}{2(6+6)\times 5{,}000}} = .624$$

For split B,

$$x_2 = 30\sqrt{\frac{30}{2(5+6)\times 4{,}500}} = .548$$

For split C,

$$x_3 = 42\sqrt{\frac{42}{2(6+7)\times 4{,}000}} = .845$$

Or, the sum of the potentials = 2.017.

The volume of air for each split is then in proportion:

Split A $= \frac{.624}{2.017} \times 75{,}000 = 23{,}203$ cubic feet.

Split B $= \frac{.548}{2.017} \times 75{,}000 = 20{,}377$ cubic feet.

Split C $= \frac{.845}{2.017} \times 75{,}000 = 31{,}420$ cubic feet.

75,000

Oily Waste in Air Receivers

Editor The Colliery Engineer:

SIR:—Replying to the question of Compressor Engineer relative to oily waste in air receivers, in your June issue, would state that "oily waste," that is, cotton waste used in wiping machinery, does not accumulate in the receiver. What does accumulate is dust and dirt and there may be fibrous material among it, but not in gobs or masses. All air carries dust, most of it generally invis-

ible, but when this dust is collected and mixed with the oil deposit, the accumulation is considerable. It is of course understood that the air should be taken as clean as possible, but absolutely clean air rarely goes through an air compressor. If there is not much sticky oil to catch the dust it may mostly go through and not be heard of.

Mechanical Engineer

The Right of Property

Editor The Colliery Engineer:

Sir:—Seeing in your issue of July, 1914, your editorial on "Force *vs.* The Constitution," will say that the right of acquiring and possessing property, and having it protected, is one of the natural, inherent, and inalienable rights of man. Men have a sense of property; it is necessary to their subsistence, and correspondent to their natural wants and desires; its security was one of the objects that induced them to unite society. No man would become a member of a community, in which he could not enjoy the fruits of his honest labor and industry. The preservation of property is one primary object of the social compact, and it is by the constitution made a fundamental law. But still, every person ought to contribute his proportion to the public burden to public purposes, though no one can properly be called upon to surrender or sacrifice his whole property, real and personal, for the good of the community, without receiving a recompense in value. This would be laying a burden upon the individual, which ought to be sustained by society at large. Nor can the legislature divest one citizen of his estate and vest it in another, with or without compensation. It would be inconsistent with the principles of reason, justice, and moral rectitude; it is incompatible with the comfort, peace, and happiness of mankind; it is contrary to the principles of social alliance in every free government; and to the letter and spirit of our constitution.

The right of taxation, and the right of eminent domain, rest substantially upon the same foundation. Private property may be constitutionally taken for public use in two ways, that is to say, by taxation, and by the right of eminent domain. These are rights which the people collectively retain over the property of individuals, to resume such portions of it as may be necessary for public use. Compensation is made when private property is taken in either way. Money is property. Taxation takes it for public use; and the tax payer receives, or is supposed to receive, his just compensation in the protection which government affords to his life, liberty, and property; and in the increase of the value of his possessions, by the use to which the government applies the money raised by the tax.

When private property is taken by right of eminent domain, special compensation is made for the following reasons: It is not taken as the owner's share of contribution to a public burden, but as so much beyond his share. Special compensation is therefore to be made in the latter case, because government is a debtor for the property taken.

Had force been used to confiscate the anthracite mines of Pennsylvania by the Federal Government, with Mr. Roosevelt as its president, the mine owners would have been entitled to special compensation for the taking of private property for a supposed public use. If there had been no special compensation paid them for this unwarranted usurpation of private property rights, we would have an instance of the constitution of our country being set aside by our Chief Magistrate. In my opinion, Mr. Roosevelt has set a very dangerous precedent, unless we are going to adopt Socialism *a la* Edward Bellamy, and let the government confiscate all of the property both personal and real.

The question deserves the consideration of all the people of this country whether they be coal miners or not. It fundamentally is a question of whether the government will usurp property rights and set aside the grand old constitution of our fathers.

Strauss L. Lloyd, E. M.

Mine Car Economy

Editor The Colliery Engineer:

Sir:—An interesting article appears in your July issue regarding the cost of mine cars. In this article you prove that the cost for mine car up-keep is $2.73 per 100 tons.

The table in the article of comparative powers required to pull roller bearing wheels as compared to solid-hub wheels is taken from a test made of the "Whitney Wonder" roller bearing wheels, of our make, as compared to solid hub wheels. These figures show a saving of power of 58 per cent. and of time of haulage of 49 per cent. These savings, however, do not affect the cost of the mine car itself per ton of coal. There are, however, a good many other points that I would like to consider with your correspondent.

The largest single item of the mine car cost is 2½ pairs of trucks at $24 per truck or $60 for 3½ years total service. I do not know what make of wheel your correspondent has used. I wish to say that we have a number of roller bearing trucks leased in Pennsylvania on a basis of the company paying us one-third the selling price per annum as a lease payment. We in turn then agree to keep up the wheels, replace any worn-out parts, and also furnish lubricant for them. This agreement means that by leasing the wheels the wheel cost can be reduced to about one-third the figures given by your correspondent. The total cost of trucks and lubricant on this table is $93.10 for 3½ years. This correspondent can lease from us with a guaranteed cost of not over $30 to $35 for 3½ years depending on the size of the wheel and axle.

Furthermore, we sell our Whitney Wonder roller bearing wheel with a 5-year guarantee attached to every part of the wheel and roller bearing guaranteeing against wear or breakage. This makes the life of the truck necessarily 5 years instead of 1 year as given in this table. If

mining wheels are scientifically made from a chemical analysis standpoint and properly annealed there is no excuse for the short life of 1 year which is given as average service by your correspondent. By this item of using a good car wheel the cost per mine car per ton is reduced to 1.54 cents. He speaks of the foundryman adhering to a suitable iron mixture for mine car wheels after it has once been discovered. This is not a practical proposition from the foundryman's standpoint, for no two carloads of pig iron are of the same analysis and each car of pig iron is a new problem unto itself unless the mixture is made strictly from a chemical standpoint.

The great trouble at some mines, and this is particularly noticeable in the anthracite regions of Pennsylvania, is that some of the officials are old fashioned and "sot" in their ways. They need some young blood, some enterprise, some interest in improvements. Many of these superintendents of the old school seem to think that nothing is of any account except those things they had when boys.

Of course, the writer does not wish to be understood as classing all superintendents in the anthracite fields as opposed to innovations, but it is a fact, that while in many instances the anthracite collieries are equipped with up-to-date machinery, there are men in official positions who are so slow in realizing the value of really good new ideas, that they never adopt them until long after their neighbors have been enjoying their benefits.

Two or three years ago the writer tried to sell a truck to the manager of a large anthracite company. The manager was a man of about 60, rather brusque in manner and not very cordial in his treatment of salesmen.

My object was to sell him a sample "Whitney" roller bearing truck. I had been about his mines and had seen his heavy hard running old cars that it took three or four men to shove, knew how antiquated his running gear was, and knew that if he would give me half a chance I could save his company much more than his salary per annum, by simply improving his mine-car truck.

The old gentleman didn't want to try any truck. Wouldn't give me a sample order. Wasn't interested. I then asked him a question or two. What is the average life of your present wheels? How often do you grease them? Is your service any more severe than that of a neighboring company I named? His average wheel lasted 12 months. He oiled his wheels every day or two. His service was no more severe than that of the other company. In fact it was almost identical. "All right, dear sir, if that is the case I will be very pleased to send you a sample truck and I will make the invoice on 12 months approval and you can examine the truck at the end of 12 months and if it is worn out you needn't pay for it. In other words, if my truck under the same service that wears out your other wheels completely shows any wear at all you needn't pay for it." Wasn't that a fair enough proposition? Do you see how the old gentleman could lose by accepting it? Wasn't he absolutely guaranteed a profitable investment? Furthermore, I told him one man could shove the mine car that it formerly took three to push and he needn't grease the wheels but once in 4 months. All this talk bored him. He didn't believe that our wheel would last longer than a year and didn't want to believe it and wouldn't believe it. "Well," I said, "in that case I lose, not you." He hated to argue against such persistence. No, he wasn't interested. Mind you, he wasn't interested in a proposition that was worth more to his company than his entire salary. "Well," I said, "make me any kind of a proposition that you want to on a sample truck, write out your own proposition and I will accept it." "No," he didn't believe he cared to do it right now. This made me more stubborn and determined to show him what a good car wheel was and I said, "Well, give me your specifications for a truck and I will present your company with a truck that is yours for nothing." When he said he didn't believe he cared to try it just at that time, I got mad and told him it was no wonder that his wheels wore out every year and that his car equipment was the poorest and most antiquated in the entire United States and cost the most money to maintain. I told the old gentleman that he never would learn anything if he didn't try and that I had no patience with any such attitude and that it was extremely discouraging to the enterprising manufacturer to run up against such conditions as this.

This is the trouble with some of the anthracite mines of Pennsylvania. This attitude of the old-fashioned superintendent is the cause of the mine car costing 2.73 cents per ton of coal mined. What is needed is some young blood and a little hustle and enterprise. I venture to say that the cost of mine cars in West Virginia averages less than 1½ cents per ton of coal mined.

One of the biggest causes of the mine car going to pieces is the dumping operation. By catching the wheels of the car the entire car is strained and racked each time it is dumped. The dumping operation not only tends to pull the truck off but also strains every bolt and plank in the car. It was never intended in designing a mine car that the dumping strains should be put on the truck bolts. It is not a correct mechanical principle. In fact, it is altogether wrong. By taking this strain of the mine car off the truck it will last one-third longer at least, and this other item of cost is thus greatly reduced. This can readily be done by installing a "Bumpa" automatic cross-over dump which catches the car on the bumper in dumping. The bumper is the strongest point of the car and the car can be caught here without strain to the truck or very much rack to any part of the car. This dump is entirely automatic in action

and is as efficient as any cross-over dump built. Rotary dumps also help solve this problem.

There are lots of ways of saving this wasted 1 cent or two a ton for mine-car expense if the mine superintendent would only give the subject a careful consideration and cooperate with the manufacturer and be willing to at least try the new improvements that are put on the market.

Hugh W. Sanford
Sanford-Day Iron Works
Knoxville, Tenn.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Crystallography, by T. L. Walker, of the University of Toronto. Published by McGraw-Hill Book Co., New York. 200 pages, illustrated. Price $2 net.

With the development of the two-circle goniometer and a new system of symbols which can be read directly from the projection, a motive for writing this book in the English language originated. The treatise is unusually clear and simple and most engineers when they recall how they were taught crystallography by lectures and by a fervid use of imagination will appreciate a book like this of Professor Walker's.

From a beginning relative to the general properties of crystals, on through their formation and chemical and physical properties, up to the irregularities of crystal surfaces, meanwhile discussing in detail all the systems encountered, it comprises an admirable presentation of the subject.

Chemical Reagents, by E. Merck. Translated from the German by Henry Schenck. 190 pages. $1 net. Published by D. Van Nostrand Co.

This is the second edition of this work and is not essentially different from the former one save that some new uses for chemicals recently discovered are included. The book is the embodiment of completeness and the nature and method of testing for every conceivable reagent are given in alphabetical order. It is an invaluable treatise for any chemist or mining engineer who makes frequent analyses.

Longwall Mining in Illinois. Nearly all of the coal produced in the United States is mined by the room-and-pillar system or some modification of it. The longwall method of mining, so well adapted to many thin seams, is neither understood nor appreciated in this country. The only field where longwall mining produces any considerable tonnage is in northern Illinois in Will, Woodford, Putnam, Marshall, La Salle, Grundy, and Bureau counties. Bulletin 5, Coal Mining Practice in District I (Longwall), by S. O. Andros, issued by the Illinois Coal Mining Investigations, describes in detail this method of mining. Longwall mines in this district produce over 5,000,000 tons of coal annually, which amount is about 9 per cent. of the production of Illinois. The production of this tonnage is attended by 24.5 per cent. of the nonfatal accidents in coal mines in the state. The per capita production per employe is only 2.1 tons as compared with 4.5 tons for the state as a whole.

The longwall method of mining makes an almost complete extraction of the coal in the bed and produces about 15 per cent. more lump coal over 1¼ inches than is produced in Illinois room-and-pillar mines.

The bulletin is illustrated by 25 sketches and flash-light photographs which show every phase of this method of mining coal. Copies may be obtained upon request from the Illinois Coal Mining Investigations, Urbana, Ill.

It is probable that the coal miners in the United States have excavated more material in one year that has been excavated in the Panama Canal zone in 11 years.

Legal Decisions on Mining Questions

Suit for Breach of Mineral Lease. (Louisiana) In Brown *vs.* Producers' Oil Co., Louisiana Supreme Court, the question of damages for breach of a mineral lease was presented. The plaintiffs, for a consideration of $20 and certain royalties, granted to the Producers' Oil Co. the exclusive right of exploiting for coal, oil, and gas, upon 66 acres of land which they owned in fee. One of the provisions of the lease was, that the oil company obligated itself to begin drilling within a certain time and to continue the work of drilling with diligence to its completion.

In case of failure to drill, the company obligated itself to pay to plaintiffs as liquidated damages, the sum of $20, and the lease was to become null and void. Upon the failure of the company to drill as specified in the contract, the plaintiffs brought this suit to recover $80,000 damages for their failure. The company tendered them $20 which they claimed was in full of all damages according to the terms of the lease or contract. The court held for the plaintiffs and a jury assessed the damages at $4,250. In a lease of valuable oil and mineral lands, the sum of $20, stipulated as liquidated damages for a breach of contract on the part of the lessee, will not be treated as a serious consideration for the termination of the lease.

Every mineral lease contains the implied condition that the lessee will use reasonable diligence in operating the premises after they have been developed.—*Brown vs. Producers' Oil Co: 64 S. 674.*

Entry Upon Mineral Lands.—(California) While any one may enter upon mineral lands of the United States not covered by a valid subsisting location, though it may be in the actual possession of another, such entry must be peaceable and in good faith, and a bad faith entry initiates no rights.—*Little Sespe Consolidated Oil Co. vs. Bacigalupi. 139 Pac. 802.*

NEW MINING MACHINERY

Arcwall Coal Cutters

*By N. D. Levin**

"Why should one pay $3,200 for an overcutting machine when he can purchase a breast machine for $1,100, or a shortwall machine for $1,750?" It is my object to reply to this question in a convincing manner. The arguments which I present will refer especially to the Jeffery Arcwall machine although they will in the majority of cases apply equally as well to any overcutting machine.

1. The machine will cut more coal than any undercutting machine in a given time, because it stays on the track while cutting, and no time is lost in unloading, moving the machine to the face, and loading up after cutting, and very little time is lost in setting jacks.

For entry work, it is necessary to place an anchor in the face for sumping. This is the only delay before the machine can be started. It is, of course, impossible to guarantee just how much work a machine will do, as it depends largely upon the crew that is running the machine, and the conditions in the mine, but from my experience with the machine I think it is safe to say that under ordinary conditions a place can be cut in 20 minutes. This will include any ordinary moving from one place to another.

2. The investment made in an overcutting machine will not be greater than that necessary where undercutting machines are used for producing the same coal output.

I think it is safe to say that it would take three breast machines or two shortwall machines to do the same amount of work as an Arcwall machine.

3. The cost of up-keep and repairs for an installation of overcutting machines for a given output will be much less than that of an undercutting machine.

I believe that it would be safe to state that one Arcwall machine will not cost more to keep up, and may be not as much, as would a breast machine, due to the fact that the machine is designed with large wearing surfaces and the parts are much stronger than in the breast machine. The fact that the machine cuts the coal without causing twisting strain in the machine, saves in the cost of repairs. As there would be three breast machines for one Arcwall machine it is evident that the cost of repairs and up-keep of the latter machine would be only one-third of what it would be if breast machines were used.

4. One of the strongest arguments in favor of an overcutting machine is that it cuts three times as much coal as the breast machine, and, this being the case, the wages of two crews are saved. How much this amounts to depends, of course, upon the local scale of mining, but in any event, it seems as though a man should earn $500 to $800 per year, which, for four men, would mean a saving per year of a sum nearly equal to the original cost of the machine.

5. Another strong argument in favor of overcutting machines is the ability to cut out dirt bands. Last week I went to the mines of the Mineral Fuel Co., at Fleming, Ky. The Consolidated Coal Co., of Fairmont, W. Va., have some mines close to Fleming, and large installations at Jenkins, about 5 miles distant. They have a dirt seam 6 feet 6 inches above the floor, and another dirt seam about half way between the upper seam and the floor. They use an Arcwall machine for cutting the upper dirt seam. There is

Fig. 1. Arcwall Machine Beginning Cut

Fig. 2. Arcwall Machine, Cut Finished

*This paper was presented before the sales convention of the Jeffrey Mfg. Co. and is of so practical a nature it is well worth an operator's reading.

about 12 inches of coal on top of this seam which is left for roof. When a place is cut the upper dirt seam is cleaned out; then shots are placed on top of the lower seam. The upper coal parts nicely from this seam, and is loaded out; then the lower dirt seam is removed and the bottom coal shot. In this manner they get a good, clean, marketable coal with a large percentage of lump in a very convenient way, considering the impurities. If it was not for the top cutting machine, I do not see how this coal could be profitably mined and marketed. Jenkins is located at the headwaters of the Big Sandy River, and Fleming is located at the headwaters of the Kentucky River, and therefore neither of these places have sufficient water supply to wash the coal; in fact, they have barely sufficient water supply for steam and other purposes. It would be possible to build washeries farther down the rivers, but it appears that the cost of rehandling and washing the coal would be prohibitive.

If I judge the situation correctly, were it not for overcutting machine, it would be difficult to operate these properties on a paying basis.

I believe there are mines where coal washeries could be done away with if overcutting machines were introduced, although I cannot name particular mines at the present time. If the impurities are scattered through the coal, it would be necessary to wash it, but if the impurities are in layers they can be removed by the machine. There would be an enormous saving effected in eliminating the washeries. I further believe there are many places where the quality of coal could be improved both by keeping out impurities and making larger coal, to such an extent that it would bring a better price.

6. The overcutting machine makes a larger percentage of lump coal, for instance in the case of the Mineral Fuel Co., if the coal was undercut and shot down, the dirt would not only be mixed in the coal, but there would be required heavy charges to bring the coal down, which would break up the coal. It is evident that when the coal is cut somewhere near the center of the bed, half of it can be shot at a time. Smaller shots would do the work, and the coal will come in larger lumps. When the coal is cut on top it seems to be shot easier than when undercut. I believe the reason is that in the case of undercut coal the shot forces the coal down and it often lies there broken up, but it does not fall out. If overcut, the action of the shots is to lift the coal, and then the action of gravity brings it down again, so that there are two forces acting on the coal, and the coal will have a tendency to slide out from the face.

7. The machine will drive straight entries providing the track is laid straight because the machine stays on the track, and the entry will be driven exactly as the track is laid.

8. Less manual labor is required, and the miners prefer to operate the Arcwall machine. The shortwall machine was quite an improvement in this respect over the breast machines, but the Arcwall machine is now in the lead. About the only labor that amounts to anything is placing an anchor in the face for the sumping cut in the case of cutting entries or narrow places. There is no slack shoveling, no digging of holes in the roof for setting jacks —the only jack needed is to pull the machine back in cutting narrow places and for that purpose a plain pipe is used, the lower end of which is ordinarily set on top of a tie, and the cable eye hooked on top of it next to the roof. The helper holds it in this position until the strain is on the rope. There is no need of using a heavy jack for this purpose, as the pull is very light. There are large convenient places provided for both men to ride on the machine. The machine is equipped with automatic reel, and with a trolley pole so that the helper does not have to pull out and handle the cable when going from one place to another. There are no tools to be handled, and no laying of skids.

9. The overcutting machine protects tender roofs.

It is evident that if the coal is cut on the top, and the shots placed at the bottom of the seam, the force of the shot will not affect the roof; the energy in the shot is used in breaking and lifting the coal, whereas, if undercut and shots are placed at the top, the force of the shot comes fully on the roof. If the seam is cut in the middle it will be necessary to place some shots near the roof, but the charge can be much smaller and will not affect the roof as much as would be the case if the coal were undercut. The operator will appreciate this point, especially in territories where timber is expensive. He will also appreciate the fact that if the roof is damaged in mining the coal, it will be a continuous expense, as it will keep on falling, break down the trolley wire, and be a constant source of danger, and that a saving can be effected by keeping the roof intact, which in some cases amounts to an enormous sum.

10. The bottom is naturally maintained by using the top cutting machine, as the cut is made above the bottom and the coal shot up.

11. Where the working places are wet, the machine runner can cut the place without working in the water to the extent he would if using a machine cutting on the bottom.

12. It is claimed that many mine explosions are caused by blown-out shots, and this is undoubtedly true. It is therefore of considerable importance that this point be considered in selecting a suitable coal cutting machine. It is evident to anybody that if the coal is cut in such a manner that small charges can be used, there is less danger of blown-out shots.

13. There is increased safety in mining, using this machine. The slogan of the day seems to be "Safety First." When I was at the mines of the Mineral Fuel Co. the officers of the company told me that they thought one of the biggest advantages of this machine was the safety to the men. They said they could not see how it was possible

for a man to get hurt unless he deliberately shoved his head into the cutter bar, and I believe that they have the right opinion, and have properly judged the advantages of the machine in this respect. With any kind of an undercutting machine, the men have to work around it, and are bound at some time or another to get close to the cutter chain and moving parts, as the machines have to be guided with skids or jacks, and the machine has to be loaded and unloaded on to and from the truck, and pulled along on the floor. During all these operations there is more or less danger of the men getting hurt. With the overcutting machine there are no such operations to go through, and there are no moving parts with which the men can come in contact except the cutter chain which is ordinarily about on the level with the face of the operator, and the operation of the machine requires him to be on the opposite side of the machine from the cutter bar.

14. This machine is more accessible than any mining machine I know of. The main drive gearing which has the hardest work, and which naturally would wear out first, can be replaced without disturbing any other part of the machine. The driving sprocket which probably has to be renewed oftener than anything else, can be taken off without disturbing any other part. The same holds true with the entire feed mechanism. The only part of the machine that is not readily accessible is the chain and sprocket underneath the truck for raising and lowering the machine, but if a pit is provided, these parts are accessible. We therefore recommend that where machines with power raising and lowering device are installed, that there be a pit made for examining this part of the machine occasionally.

15. As it takes an enormous strain to swing the machine around on the turntable with the cutter arm in the coal, probably 10 feet away from the center of the machine, the machine has been designed so that the ¾-inch feed rope is the weakest part of the feed mechanism, and is also at the same time the cheapest and most readily replaced.

16. A disk friction clutch controls the feed. The feed-drum which winds up the feed-rope is provided with a disk clutch having 28 disks. The clutch acts as a safety device in probably 99 cases out of 100, but the one-hundredth case will happen occasionally. I know of one instance where the machine runner had an inexperienced helper; they tried to feed the machine around while the turntable was locked, and the helper tightened up the clutch as hard as he could with his hands, but when the machine did not start up, he found a crowbar and put it into the hand wheel and tightened it up still more, until the rope broke. Any ordinary miner will soon learn that if the machine does not start up when he is tightening up the clutch hand wheel with his hands, there is something wrong, and therefore the disk will even protect the weakest part of the machine, which is the rope, except on very rare occasions, as, for instance, such a case as mentioned above.

The disk clutch has another advantage; if the bits should encounter some unusually hard material that cannot be cut fast enough for the ordinary feed, the operator can let the clutch slip, and the cutter bar will be practically stationary, but with pressure against the material to be cut. In this manner it is often possible to go through places that could not be cut with the ordinary feed.

17. It is essential that this machine be equipped with a feed that is adjustable while the machine is running. When the machine is cutting in a semicircular face, at the beginning of the cut the cutter arm is not deep in the coal and can be fed at a high rate. As it advances into the coal it has more and more of a cut until it is in to its full depth. The rate of feed can be reduced from the highest to the lowest while the machine is running.

18. The truck, self-propelled by an independent motor and a disk clutch, allows a speed variation from zero to 250 feet per minute without using the starting box. A band brake controls the speed down grade.

The reason for providing the truck with an independent motor was to make it possible to propel the machine with the cutter arm placed in any position. In cutting narrow places, the machine is brought in with the cutter arm toward the coal face, and into the rooms it is brought with the cutter arm pointing away from the face. Another reason was to provide a simple device for raising and lowering the machine by power.

The disk friction clutch for controlling the speed of the truck makes it possible for the machine runner to go over bad tracks and short curves, without burning up the starting box. There are more starting boxes burned up by propelling a machine than by the cutting. When the machine is on an entry where there is a trolley wire, it can be run like a locomotive.

A Sectionalized Pumping Engine

By Oscar C. Schmidt

The severe service under which a pump must operate in mines has brought about a pumping engine which is durable and fulfils the demand for accessibility and interchangeability of parts. This new pump recently installed in the Prospect colliery of the Lehigh Valley Coal Co., Wilkes-Barre, Pa., by the Scranton Pump Co., of Scranton, Pa., is one of the largest in the Wyoming Valley.

As shown in Fig. 3 it is of the direct-acting, duplex, compound condensing, semirotative steam-valve pattern, with four single-acting centrally packed water plungers built under special specifications. This pump has over-all dimensions of 35 feet in length, 12 feet in width and 9 feet in height with a capacity for pumping 2,000 gallons per minute under a head of 560 feet.

The high-pressure steam cylinders are 22 inches in diameter, the low pressure 42 inches, the plungers 14 inches, all having a stroke of 36 inches. The high- and low-pressure steam cylinders are arranged tandem, with the high-pressure cylinders between the low-pressure cylinders and water end. The valve gear is of positive construction so plate to which they are bolted, insuring rigid alinement of water end. The respective pairs of water cylinders on the same side of the pump are connected by three steel tie-rods which are secured to tie-rod bosses cast on the stuffingboxes.

Both sides of the pump are connected by a cross-suction pipe with single outlet, the dead ends of the excessive strain being placed on the tie-rod flanges.

The admission and exhaust valves are of the semirotative type, two on the high-pressure cylinders and two on the low-pressure cylinders, all placed underneath so as to insure complete drainage of condensation or entrained water without danger to heads or pistons.

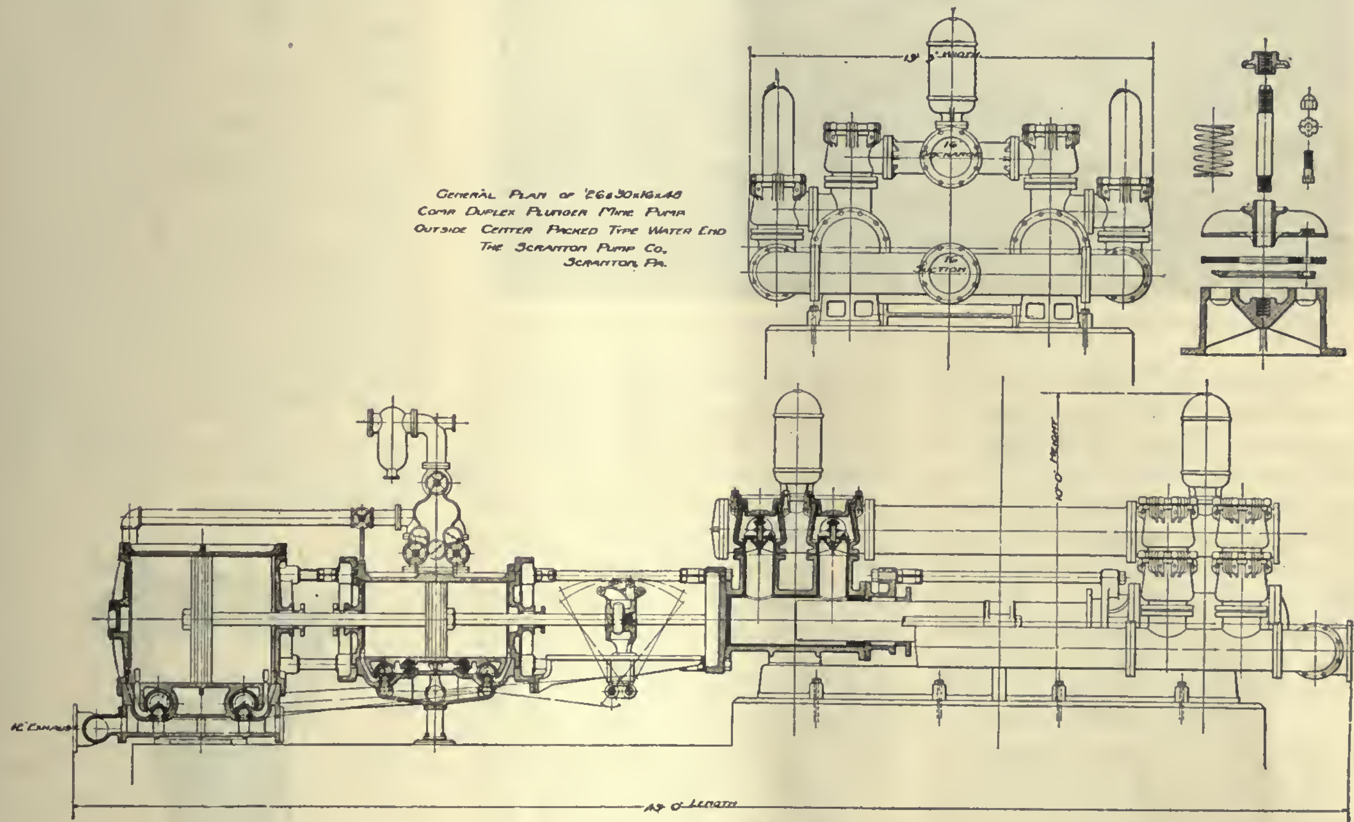


Fig. 3. Sectionalized Pumping Engine

that under no working conditions can the pump become centered or stopped.

One of the features of this pump is the tie-rod construction. Each steam end is connected to its respective water end by four cold rolled steel tie-rods which are secured to heavy tie-rod flanges, which are in turn secured to the high-pressure cylinders at one end and at the other to the working barrels. The high- and low-pressure steam cylinders are connected together in a similar manner.

The pump has four interchangeable cast-iron water cylinders, 14 in. × 36 in., arranged in pairs on each side of the pump. The two sides are connected by means of a base suction pipe being provided with vacuum chambers. Two alleviators are placed on the discharge pipe.

Automatic air valves are placed at the high points on the water cylinders. These allow the air to be discharged from the water cylinders on the discharge stroke and automatically close on the suction stroke to prevent air from reentering the water cylinder, thus facilitating starting.

To each end of the high-pressure cylinder is bolted a heavy tie-rod flange. This flange is counterbored, fits on a turned projection on the cylinder face, is independent of the steam cylinder head, and prevents any spring in the joint on the high-pressure cylinder head in case of

The condensing equipment used with this pumping engine is of the independent single cylinder kind, 12 in. × 18 in. × 18 in., double acting with a 10-inch condenser, which gives a vacuum of 26 inches when it is working under normal conditions.

The water cylinder of the air pump is bronze fitted, the valves are made of soft rubber with an acid resisting plate covering the entire valve. All the other parts of the air pump are protected from the corroding qualities of the water which it must handle.

The total weight of the pump is 140,000 pounds, the weight of the condensing apparatus is 9,000 pounds.

Sullivan Ironclad Coal Cutters

The latest model of an electric chain cutter for room-and-pillar work is the new Sullivan Ironclad continuous coal cutter.

Fig. 4. Result of One Shot After Undercutting at Furnace Run Mine, Kittanning, Pa.

To operate the machine, it is unloaded from its self-propelling car as close to the face as the track in the room will allow. A jack is set close to the wall or rib of the room, and the machine drags itself across the floor to the rib on the feed chain. The sumping or corner cut is made in a way like that employed by the older "breast" machines; by means of a starting pan or frame, which secures a straight, true wall. When the cutter bar has been fed entirely under the coal, this pan is removed and the machine cuts its way across the face to the other rib by gearing and drive sprockets acting on a feed chain, which is anchored by a jack-pipe. When the face cut is completed, the machine is backed out from under the coal, loaded onto the truck, and is ready for the next working place.

The labor involved in removing and setting posts for the breast machine, of barring it across from one cut to the next, and in handling jacks, is all avoided when the continuous cutter is employed. This machine performs all the operations by its own power.

The power required to operate the machine is much less, per ton of coal mined, or per cubic inch of coal removed, than that needed for many other machines. In coal of average hardness, the machine requires 12 to 20 horsepower while mining. About 4 horsepower are consumed when loading, unloading, and moving from place to place.

The total maintenance charges for one year, on ten Ironclads used by a Pennsylvania coal mining company, are reported as $11.80 per thousand tons mined, or .0118 cent per ton. This included the actual value of the replaced parts, and the labor involved in replacing them.

As compared with breast machines, this cutter has the following advantages: its compactness and flexibility enable it to work under bad top with a far higher factor of safety; it requires less labor, both in handling and in loading coal; it cuts more rapidly and uses less power; it makes cleaner mining, secures larger coal; follows rolling bottom; works in pitching beds; and the cost of maintenance is lower.

Safety First in Riveting

Following the recent "Safety First" movement, several states are drafting safety appliance laws, among the provisions of which are requirements that riveting hammers embody in their construction devices to prevent the accidental ejection of the rivet set from the nozzle of the hammer. One of the most novel rivet-set retainers is that now put out with the "Little David" pneumatic riveter, shown in Fig. 5.

The retainer consists of but a single piece of heavy spring steel, closely wound into a spiral form. One end of this spring fits over the outside of the hammer nozzle and hooks over a projection integral with the nozzle. The other end is wound to a smaller diameter. Sets for rivets over ⅞-inch diameter are formed with a coarse thread and are simply screwed into place. Sets for rivets ⅞-inch diameter and smaller are formed with a shoulder and are slipped into the retainer while it is detached from the hammer, the shoulder holding it in place. The device prevents the rivet set or piston from being driven out, even when the hammer is run free.

Other important improvements have been embodied in the "Little David" riveter. There is but a single ground joint between handle and barrel and these parts are securely held together by two bolts, one on either side of the barrel. This construction eliminates the need of a vise in taking the tool apart for inspection.

Fig. 5. "Little David" Riveter

"Little David" riveters are manufactured by the Ingersoll-Rand Co., of New York. They are made with either outside or inside types of triggers, in five regular sizes adapted

for all kinds of riveting work. In addition there are two sizes of jam riveters which have an exceptionally short over-all length, making them peculiarly well adapted for riveting in very cramped quarters.

TRADE NOTICES

"Proto" Rescue Apparatus.—Announcement is made by H. N. Elmer, the North American agent for Seibe, Gorman & Co., that the Proto mine rescue apparatus will be sold in the East by the Mine Safety Appliances Co., 541 Fourth Avenue, Pittsburg, Pa. This company is owned and controlled by G. H. Deike and J. T. Ryan, both of whom are mining men of experience formerly connected with the United States Bureau of Mines in investigation and rescue work.

The Sullivan Machinery Co. announces that Mr. J. C. West, hitherto local manager at San Francisco, has been transferred to Chicago as general sales engineer. Mr. Ray P. McGrath, for several years associated with the Boston office of that company, has been appointed to fill the vacancy at San Francisco.

The General Electric Co. has recently received orders for electrical equipment as follows: The Asher Coal Mining Co., Pineville, Ky., a 435 kv-a. synchronous motor-generator set with an 8-kilowatt exciter and switchboard and 8-ton and 6-ton electric mining locomotives. The Vinton Colliery Co., Vintondale, Pa., a 15-ton electric mining locomotive. The U. S. Coal and Oil Co., Holden, W. Va., eight 6-ton electric mining locomotives. The Solvay Collieries Co., Springton, W. Va., a 12-ton electric mining locomotive. The Alleghany River Mining Co., Kittanning, Pa., two 8-ton electric mining locomotives.

Carels Diesel Engines.—The Nordberg Mfg. Co., of Milwaukee, Wis., is now building Diesel engines of the largest sizes, having recently entered into manufacturing arrangement with Usines Carels Freres, of Belgium, builders of the celebrated Carels engines. The design of the Nordberg-Carels Diesel engine is under the direct supervision of Mr. B. V. Nordberg, who has concentrated practically his entire attention on the Diesel engine for several years.

The Clinchfield Corporation, of Dante, Va., has contracted with the Roberts and Schaefer Co. for approximately $50,000 for a Marcus patent five-track steel coal tipple with a 600 feet long inclined car haul, to be electrically operated, at their mine at Hurricane, Va.

Compressed Air Locomotives.—A catalog recently issued by the H. K. Porter Co., of Pittsburg, entitled "Modern Compressed Air Locomotives," describes particularly the locomotives made by that company. It also gives a history of the compressed-air locomotive and a treatise of the thermodynamic principles on which the success of such locomotives depends.

The Link-Belt Co. has been awarded contract from the Red Jacket Consolidated Coal and Coke Co., Red Jacket, W. Va., for a complete shaking screen tipple, consisting of picking tables, shaking screens, loading chutes, etc. The Link-Belt Co. has also nearly completed the tipple equipment for the Main Island Creek Coal Co., at Omar, W. Va. It is of steel construction and equipped with a long apron conveyer for bringing the coal from the drift mouth to the shaking screens at the foot of the hill where it will be sized into lump, egg, nut, and slack and their respective mixtures. The lump and egg, respectively, will be delivered to picking tables and loading booms to insure its being delivered to the cars with a minimum amount of breakage. By-passes are provided so that run-of-mine coal can be loaded directly into railroad cars without going over the screens.

The Link-Belt Co. has also started the erection work of a large steel tipple of the shaft type for the New River Co., at Scrabro, W. Va., to replace a wooden tipple which was burned down some time ago.

The Westinghouse strike at East Pittsburg was called off by the workmen on Thursday, July 9. While the day set for return to work was Monday, July 13, a large number of the men reported on the Friday and Saturday preceding. The works are now running full time.

Safety First

*By John McCracken**

When you go down in this mine,
Always let your thoughts incline
To Safety First.
There is danger anywhere,
For yourself and others care,
To shun duty never dare.
Remember Safety's First.

If your work is on the slope,
Always look out for the rope,
Safety's First.
There may be a broken bar,
Which may loosen every car,
Though the trip be near or far,
Remember Safety's First.

If you may be driving mules,
Always live up to the rules,
Safety's First.
Use your sprags in going down hill,
Or perhaps you'll cause a spill,
And yourself and mule may kill.
Remember, Safety's First.

If you're working near a wire,
Your best judgment you require,
Safety's First.
Never touch it, slow or quick,
Do not use a drill or pick.
If you must then take a stick,
Remember, Safety's First.

When you reach your working place,
Look for gas along the face,
Safety's First.
Examine well the top,
Make secure with board and prop,
Or perhaps something may drop.
Remember Safety's First.

If your place is making gas,
Cause the air to freely pass,
Safety's First.
Lead your brattice to the face,
Let the air the gas displace,
Careful be in every case.
Remember Safety's First.

There are dangers on the top,
In the engine room and shop,
Safety's First.
Couple cars both front and rear,
See that everything is clear,
Signal right the engineer.
Remember Safety's First.

When in doubt just ask the boss,
Or you'll maybe suffer loss,
Remember Safety's First.
Life is very sweet and dear,
To "Safety First" you must adhere,
Then you'll have no cause to fear.
Safety's First.

J. M. Roan, head of the Department of Mines with the Ohio Industrial Commission, has arranged to put the state mine inspectors through a vigorous course of instruction in handling the new rescue car, recently completed. They will be taught all the phases of rescue work and mine fire fighting.

*Written for the Alabama Fuel and Iron Co. by John McCracken.

Coal Production in 1913

Statistics in Regard to the Output, Value, Number of Employes, Working Days, Accidents etc., of the Different States

The following statistics in regard to the production of coal in the United States are from figures given by E. W. Parker, of the United States Geological Survey, except where otherwise noted.

Alabama.—The production of coal in Alabama in 1913 amounted to 17,678,522 short tons. The increase over 1912 was 1,577,922 tons, and went principally to points outside the state. The number of men employed in 1913, 24,552; the number of men killed, 124; the total time lost by strikes, 27,041 days.

Arkansas.—There was a gain of 133,288 tons in the output of coal in Arkansas over 1912, in all making a total of 2,234,107 tons worth $3,923,701. Arkansas semianthracite coal has established a market in the northwest, where it has to some extent replaced West Virginia smokeless. The number of men on strike, for one cause or another, was 1,221, or a few more than one-fourth the number of men employed at coal mining. There were 12 fatal accidents, or 1 for each 350,137 tons coal mined.

Colorado.—The production of coal in Colorado in 1913 was 9,232,510 tons valued at $14,035,000. This was a decrease of 1,745,314 tons below 1912, and was due entirely to labor agitators trying through foreign miners to make Americans join their labor union. There were 108 fatal accidents in the coal mines of Colorado.

Georgia.—Prior to 1904 the principal labor employed in the coal mines of Georgia consisted of convicts leased from the state government. An act of the legislature prohibiting further leasing of convicts to industrial enterprises caused the gradual withdrawal from the coal mines of this labor as contracts expired, and operators in the somewhat isolated region where the mines are located were not at once able to supply the deficiency by free labor.

The influence of free labor on the efficiency record is shown by the fact that in 1907, when the principal labor was performed by convicts, it required 808 men working an average of 262 days to produce 362,401 tons, an average of 449 tons per man for the year and of 1.71 tons for each working day. In 1913, with 500 men working 261 days, 255,626 tons were produced, the averages per man being 511 tons for the year and 1.95 tons a day.

Indiana.—The production of coal in Indiana in 1913 was 17,165,671 short tons, valued at $19,001,881. Although this was an increase of 1,879,953 short tons, or 12.3 per cent., over 1912, it fell short of the record output of 1910 by more than 1,200,000 tons.

In spite of the adverse conditions which prevailed in 1913, labor was in better supply and the number of working days made by the employes was greater than in 1912. The total number of employes in the coal mines of Indiana increased from 21,651 in 1912, to 22,235 in 1913, and the average working time from 182 to 190 days. The average annual production per man increased from 706 to 772 tons, and the average daily production by each man from 3.88 to 4.06 tons.

The increased efficiency was due in part to the larger proportion of the product being mined by machines, the increase in that item contributing two-thirds of the total increase, or 1,270,387 tons. The production of machine-mined coal in 1913 amounted to 9,634,146 short tons, or 56 per cent. of the total, compared with 54.7 per cent. in 1912.

The number of fatal accidents reported to the Bureau of Mines for 1913 was 66, compared with 40 in 1912.

Iowa.—In 1913, Iowa produced 7,490,641 tons of coal valued at $13,431,061. This was an increase of 201,112 tons over 1912, and is said to be due to the Colorado strike. The coal beds of the state are not thick, the thickest in the Des Moines district being 5 feet; at the same time they are irregular and faulted, non-coking, high in sulphur, but fair steam fuel. The number of coal mine workers in Iowa is 15,679. The quantity of coal shot off the solid was 72 per cent. of the total. There were 26 fatal accidents all underground and 18 due to fall of roof.

Kansas.—The coal miners of Kansas produced 7,202,210 short tons in 1913, valued at $12,036,292. This was a substantial increase over 1912, especially in the value of the output, which advanced more than 6 per cent. The production in 1912 was 6,986,182 short tons, valued at $11,324,130.

The only unfavorable incidents were occasional shut-downs at the stripping operations because of high water in the spring and some inconvenience during the drought in the summer and early fall, when water for the boilers had to be hauled to the mines.

Shooting from the solid continues to be practiced in the coal mines of Kansas, although there was a slight improvement in that regard in 1913.

The number of men employed in the coal mines of the state in 1913 was 12,479, and the average production per man was 577 tons for the year. The number of fatal accidents reported to the Bureau of Mines in 1913 was 28.

Kentucky.—The production of coal by Kentucky mines for 1913, as given by C. J. Norwood, Chief Inspector of Mines, shows a gain of more than 3,000,000 tons over the output for 1912. The total output was 19,421,288 tons. This refers only to commercial mines, and the aggregates are made up from monthly reports received from coal companies throughout the year.

The output according to districts,

with figures for 1912 given for comparison, was as follows:

	1912	1913
Western district	7,705,904	8,436,155
Southeastern district	5,182,829	6,061,626
Northeastern district	3,345,171	4,923,507
Total	16,323,904	19,421,288

The commercial output has almost doubled within the last 5 years, and the rate at which it has grown is shown by the following figures: 1909, 10,296,145; 1910, 14,720,011; 1911, 13,924,811; 1912, 16,323,904; 1913, 19,421,288.

Up to 1911 the annual production of the western field exceeded that of the eastern one, but in that year the output of the latter field passed that of the former and the annual excess has grown rapidly. In 1912 the excess for the eastern field was 732,096 tons; and in 1913 it was 2,548,978 tons. The prospect is that within another 5 years the output of the eastern field alone will exceed the total production for the entire state for 1913.

There are now approximately 32,000 persons employed at and in the coal mines. The number so employed during 1913 was 29,335.

Missouri.—The production of coal in Missouri in 1913 was 4,318,125 short tons, valued at $7,468,308, a decrease compared with 1912 of 20,731 tons in quantity and of $165,556 in value. With the exception of 1912, however, the output in 1913 was the largest in the history of the state. The decreased production in 1913 was due primarily to the exceptionally mild weather in February and March, the output in those two months being nearly 135,000 tons less than in the corresponding period in 1912. The coal mining industry suffered somewhat from the drought during the summer and at times water for boiler use had to be hauled to the mines. There was little interruption to mining operations on account of labor troubles.

The number of fatal accidents in the coal mines of Missouri in 1913 was reduced to just one-half of the fatalities of the preceding year, or from 20 to 10, according to reports to the Bureau of Mines.

Montana.—The production of coal in Montana in 1913 amounted to 3,240,973 tons valued at $5,653,539. This is a record, being in excess of the 1912 production by 192,478 tons. Number of men employed 3,630; days worked 228; tons mined per man employed 893; average daily output per man employed 3.92 tons. Number of fatal accidents 20. The increase in demand came from coal being used for domestic purposes.

North Dakota.—In 1913, 495,320 tons of lignite were mined in North Dakota, used chiefly for domestic purposes. The Government owns and works a coal mine at Williston in connection with an irrigation project. The water is raised from the Missouri River by means of steam pumps and delivered to an extensive system of canals and ditches by which a large section of the Missouri River valley is irrigated.

Ohio.—The coal production of Ohio in 1913 amounted to 36,200,627 tons, a gain of 1,671,900 tons over 1912. The average value per ton was $1.10. In 1913, 32,642,848 tons or 90.2 per cent. of Ohio's production was mined by machine, an increase of 2,604,017 tons over 1912. Less than 4 per cent. of the coal was shot off the solid.

Pennsylvania.—The production of anthracite for 1913 was 81,718,680 long tons valued at $195,181,127. Another record in addition to that of tonnage was established in the anthracite region in 1913. The average working time for men, 257 days, exceeded anything in the history of the industry, the nearest approach being in 1911, when an average of 246 working days was recorded. In 1912 the average was 231 working days. The average number of men employed in 1913 was 175,745.

Reports to the Bureau of Mines show that there were 618 fatal accidents in the anthracite mines in 1913 compared with 584 fatalities in 1912.

Tennessee.—The production of coal in Tennessee in 1913 was 6,903,784 short tons, valued at $7,883,714. This is an increase in production of 430,556 short tons and $503,811, or nearly 7 per cent. in both quantity and value, compared with 1912.

The coal mines of Tennessee were not entirely free from labor troubles in 1913, as there were 857 men on strike during the year, with an average of 50 days each of lost time. The total number of men employed in 1913 was 11,263, and the average production per man was 613 tons for the year.

The quantity of coal washed in 1913 was 707,773 tons, which yielded 624,426 tons of cleaned coal and 83,347 tons of refuse. Most of the coal washed is slack used in the manufacture of coke. The coal mining fatalities in Tennessee in 1913, according to the Bureau of Mines, were 35, compared with 18 in 1912.

The United States census of 1840 states that 558 short tons of coal was produced in Tennessee in that year. By 1860 the production had increased to 165,300 tons, but after that date development was retarded by the Civil War. Since 1870 the production of Tennessee has increased rather regularly, but not so rapidly as that of Alabama.

Texas.—In Texas in 1913, 2,429,144 tons of coal were mined. It was nearly evenly divided between lignite and bituminous coal, the value of the fuel being $4,288,920.

The coal beds in Texas belong to three geological periods, Carboniferous, Cretaceous, and Tertiary. The Carboniferous coals are in the north central part of the state. The Cretaceous coals occur in the southern part of the state and extend into Mexico, being mined extensively at El Fenix, and Esperanzas. They are semibituminous and make a fair grade of coke. This was once called the Sabinas coal field.

Lignite beds extend from the Sabine River in the northeast to the Rio Grande River in the southwest.

Virginia.—This state broke all previous records and produced

8,828,068 tons of coal valued at $8,952,653. The number of men employed in 1913 was 9,162, and the average production per man 963 tons for the year and 3.44 tons per day. There were 24 fatal accidents.

Washington.—For the first time in 3 years the coal production of Washington in 1913 showed an increase over that of the preceding year. The production in 1913 was 3,877,891 short tons, valued at $9,243,137, a substantial increase over the output of 1912 amounting to 516,959 short tons, or 15 per cent. in quantity, and $1,200,266 or nearly 15 per cent. in value. Even this increase, however, did not bring the output up to the record made in 1910, when the maximum product of 3,911,899 tons was mined. It indicates, nevertheless, a recovery from the depressed condition into which coal mining in Washington was forced in 1911 and 1912 by the competition of California petroleum as a railroad and manufacturing fuel. The use of petroleum continues, but the increase in population and improved business conditions have furnished a better market for Washington coal than was available in 1911 and 1912. The slightly lower average value per ton in 1913—$2.38 as compared with $2.39 in 1912—was due rather to the ability of operators to dispose of some of the less desirable grades than to any actual decline in prices. In 1912 the average value per ton was 10 cents higher than in 1911, although demand was light and production decreased over 200,000 tons, the fact being that in 1912 such demand as existed was largely the demand for domestic consumption, which preferred higher grades of screened coal and left the slack and lower grades a drug on the market. The generally improved tone in the coal mining business of the state in 1913 is shown by the fact that increased production was made in every county. The quantity of coal made into coke, all from Pierce County, increased from 76,741 tons to 118,698 tons. Most of the coke goes to the smelter at Tacoma.

Reports to the United States Bureau of Mines show that there were 22 fatalities among the 5,794 coal miners of Washington in 1913.

West Virginia.—With a production in 1913 exceeding for the first time in its history a total of 70,000,000 tons, West Virginia became firmly established as the second in rank among the coal producing states. The production in 1913 was 71,308,982 tons, showing a gain of 4,522,295 short tons, or nearly 7 per cent. over the output of 1912 (66,786,687 short tons), up to that time the record tonnage. The increased production was accompanied by a considerably larger gain in value, which showed an increase over 1912 of $9,079,931, or 14.46 per cent. The value of the output in 1913 was $71,872,165. The average value per ton for the first time in 10 years exceeded $1. The production increased in 1913 in spite of the fact that the labor troubles in the Paint Creek and Cabin Creek districts of the Kanawha field, which began in the early part of 1912, were not settled until well into the spring of 1913, and that the unprecedented floods in the Ohio Valley in the spring reduced shipments to the West for a time. A few of the mines that were closed by the strike were not reopened during 1913, and the total production from the two districts affected was much below the normal output. The increased production was well distributed, but three counties out of thirty showing decreases.

A workmen's compensation bill was enacted in February, which provided that 1 per cent. of the pay rolls should be paid into the compensation fund, 90 per cent. by the employers and 10 per cent. by the employes.

According to the Bureau of Mines, the number of fatal accidents in the coal mines of West Virginia showed a decrease of 22, from 359 in 1912 to 337 in 1913, although there was an increase of nearly 10 per cent. in the number of men employed. Labor troubles caused the loss of 377,405 working days, or an average of 43 days for 8,800 men idle.

Wyoming.—The production of coal in 1913 was 7,393,066 short tons, with a spot value of $11,510,045. This production showed an increase of 24,942 short tons over 1912 in quantity, but a decrease of $138,043 in value. The output from Sweetwater County, which produces nearly 40 per cent. of the total, is derived largely from mines controlled by the Union Pacific Railroad, and in Lincoln County a large part of the production is also controlled by railroad interests, but in Sheridan County the product is chiefly commercial coal. Conditions were generally satisfactory throughout the year, and not a single strike or lockout was reported.

In 1912 a new county, Lincoln, was carved out of Uinta County, and in 1913 the portion of Big Horn County in which coal is mined was made into Hot Springs County, Big Horn ceasing to be a coal producing county.

Wyoming continues to maintain a high record for efficiency in the rate of production per man employed. The number of men employed in 1913 was 8,331, who worked an average of 232 days in the production of 7,393,066 tons of coal.

It is gratifying to record a decreased percentage in the production of "powder-mined" coal. In 1912, 3,180,067 tons, or over 40 per cent. of the total, was shot off the solid; in 1913 that part of the output amounted to 2,719,884 tons, or not quite 37 per cent. Another gratifying record made by Wyoming in 1913 was a decrease in the number of fatalities reported by the United States Bureau of Mines. In 1912 there were 34 deaths by accident and in 1913 there were 26, due to falls of roof, falls of coal, haulageway accidents, etc. The record for the year was free of gas or dust explosions.

It is said that every variety of coal save anthracite is found in Northumberland and Durham counties in England. History reveals the astonishing fact that the fields there have been worked at least 700 years.

Answers to Examination Questions

Questions Asked at an Examination for Foreman and Assistant Foreman, Held in Pottsville, Penna., May 25, 1914

(Concluded from July issue)

Ques. 19.—While the fan is running at the same speed, will a larger quantity of air pass through an airway 8 ft. × 10 ft. than through one 6 ft. × 8 ft. Explain why.

Ans.—A larger quantity of air will pass through the airway with the larger cross-section because the friction is less. Assuming the pressure, length, etc., to be the same in each airway, the variable quantities being the area a and perimeter o, the quantities in circulation will be in ratio $a\sqrt{\frac{a}{o}}$, or $80\sqrt{\frac{80}{36}} : 48\sqrt{\frac{48}{28}} = 119.2 : 66.7 = 1.8 : 1$. In the foregoing, the respective areas are $8 \times 10 = 80$ square feet and $6 \times 8 = 48$ square feet; and the perimeters are $2 \times (8+10) = 36$ feet and $2 \times (6+8) = 28$ feet.

Ques. 20.—If a fan should double its speed and increase the ventilating pressure fourfold, in what proportion would the quantity of air be increased?

Ans.—If the speed of the fan is double, so will be the quantity of air in circulation. Likewise, if the pressure is increased fourfold, the quantity of air in circulation will be increased in the ratio of the square roots of the original and increased pressures, or as $\sqrt{4} = 2$. In practice it is found that the quantity varies as fifth root of the fourth power of the speed, and the pressure as the fifth root of the eighth power of the speed. Thus, if the speed is doubled, the quantity will be increased 1.74 times, and the pressure 3 times.

Ques. 21.—Is there a disadvantage or loss in having the air travel at high speed? Why?

Ans.—Yes, because the friction increases as the square of the velocity. Further, at high velocities of the air-current it is difficult to keep open lights burning, and the flame may be blown through the gauze of a safety lamp.

Ques. 22.—Describe the dangerous gases found in coal mines; how are they produced; what are the dangers attending the presence of each, and how may each be detected?

Ans.—Methane, or marsh gas, CH_4, which, when mixed with air is known as firedamp. It is odorless, tasteless, and colorless, and its specific gravity is .559. It is given off from the pores of the coal and was formed by the decomposition of vegetable matter in the absence of air and in the presence of water. It is highly explosive and is detected by means of the safety lamp.

Carbon dioxide, or carbonic acid gas, CO_2, which, when mixed with air is known as blackdamp. It is odorless and colorless and has a sweetish taste. Its specific gravity is 1.529. It is the product of the combustion of vegetable matter and is also produced by the breathing of men and animals, the burning of lamps, etc. It is not explosive, but in sufficient quantity produces headache and nausea, and eventually death by suffocation. It can be detected by the dimming or extinguishing of lights in its presence.

Carbon monoxide, or carbonic oxide, CO, which when mixed with air is known as whitedamp. It is odorless, colorless, and tasteless, and its specific gravity is .967. It is the product of imperfect combustion, that is, of burning without sufficient oxygen to form CO_2. It is produced by the explosion of many powders, but is chiefly formed by the slow combustion of coal where the ventilation is poor as in gobs and abandoned workings, and by the explosion of coal dust. The gas is highly explosive, although rarely if ever present in sufficient quantity to be ignited. While it will show a cap on the flame of a safety lamp, this test is not available, as an amount of gas sufficient to produce a cap is fatal instantly or in a few seconds. A quarter of 1 per cent. if breathed for a few minutes, particularly while working, causes drowsiness and death. It may be detected by its effect upon small birds or mice, which are much more sensitive to the gas than men.

This gas acts upon the system by combining with the red corpuscles of the blood to the exclusion of oxygen.

Hydrogen sulphide, or sulphuretted hydrogen, H_2S, which when mixed with air is known as stinkdamp. It is colorless but has a very strong smell similar to that of rotten eggs. Its specific gravity is 1.192. It is sometimes given off by coal seams or by the rocks, and is produced by the decomposition of organic matter where sulphur is present. It is very similar to carbon monoxide in its explosive and poisonous properties. The best, if not the only, test for its presence is its distinctive smell.

Ques. 23.—What are the provisions of the mine law regarding the examination of old and new workings in a mine?

Ans.—If the abandoned parts of the mine have been found to contain explosive gas, they must be examined therefor at least once a week;

such dangerous accumulations as may be found must be removed at once; and the necessary report thereof made in the record book.

The regular workings must be examined every morning, breasts, traveling roads, and all other parts where men may go. The examination must be made with a safety lamp not more than 3 hours before time for beginning work, and the workmen must not enter the mine or their working places until the mine or the working place are reported safe. A report of each examination must be entered in the mine record book.

Either the foreman or his assistant may make the required examination, and sign the report.

QUES. 24.—At what points in a mine would you expect firedamp to be standing, and how does firedamp appear in a safety lamp?

ANS.—Firedamp will be found at the highest points in the workings; that is at the face of all places driven to the rise. The burning gas forms a blue cap upon the flame.

QUES. 25.—What proportion of carburetted hydrogen is mixed with the air when a cap begins to appear on the safety lamp, and at what proportion does it explode?

ANS.—The proportion of gas which will show a cap upon the flame depends upon the type of lamp used, and the skill and experience of the observer. Using the ordinary Davy lamp, the average skilled fire boss notices a cap when the air contains about 2 per cent. or 1 part in 50 of this gas. Special lamps burning special oils or provided with special devices, enable as little as 1 per cent. or 1 part in 100 to be detected. The explosive point is reached when the mine air contains from 5 to 5.5 per cent. of the gas, or in the proportion of 1 to 20 to 1 to 18.

QUES. 26.—Is it safe to swing a safety lamp through an explosive mixture of gas, or to carry it against a current of air heavily charged with explosive gas? Why?

ANS.—The practice of swinging a lamp in explosive mixtures or carrying it rapidly against an air-current charged with gas is dangerous, as the flame of the lamp may be forced through the gauze and cause an explosion.

QUES. 27.—Are these conditions possible where a body of carburetted gas may, after accumulating, prevent the air-current from passing? Describe them.

ANS.—An accumulation of methane cannot stop the air-current, nor can a large body of this gas form where the ventilation is active. The conditions described may arise in the first case, through the regular outflow of gas in a place where the ventilation is sluggish, and in the second case, from a sudden and violent outburst of gas, where the ventilation is generally good.

QUES. 28.—What are the principal causes of fires in coal mines, and what precautions should be taken to guard against them?

ANS.—Fires may be started by the ignition of the firedamp through the use of open lights, matches, fuse, or squibs. The burning methane may ignite the timbers and even the coal. Other sources of fire are the short-circuiting of imperfectly insulated electric wires, carelessness in throwing matches, old wicks, etc., in piles of timber, chips, etc., and, possibly, spontaneous combustion. Eliminate the causes and fires will not occur.

QUES. 29.—What instruments are necessary for a mine foreman in the management of a mine?

ANS.—An anemometer to determine the velocity of the air-currents, a water gauge to determine the friction of the air, a compass to indicate the direction of the working places, a barometer to measure the pressure of the atmosphere, a safety lamp to detect the presence of methane, a watch to be used with the anemometer in determining the velocity of the air, a tape for measuring distance, and a slope or degree level for ascertaining the slope of pitching places.

QUES. 30.—The volume of air entering a mine is equal to 150,000 cubic feet per minute measured at a temperature of 60° F. What will be the volume of the air leaving the mine if the temperature is increased to 68° F. in its passage through the workings?

ANS.—Assuming the pressure of the air as recorded by the barometer is constant, the volume of the outgoing air will be increased in the ratio of its absolute temperature to the absolute temperature of the intake air. Whence, volume of outgoing air $= \frac{460+68}{460+60} \times 150{,}000 = 152{,}308$ cubic feet.

QUES. 31.—A shaft 500 feet is to be enlarged; how would you proceed to do the work having special regard to the safety of the workmen?

ANS.—If the mine can be shut down during the time the enlarging is going on the safest way to do the work is to fill the shaft with culm or fine coal. To do this, heavy bulkheads are built around the foot of the shaft so as to close all access to the workings. Culm is then run in either dry, or, more cheaply, by flushing it in with water in the ordinary way. After the shaft is full, the culm forms a floor for the men to stand upon while blasting the shaft to its enlarged dimensions. As fast as the shaft is enlarged, the culm is hoisted out and the timbering placed.

QUES. 32.—What safe method would you adopt to work breasts on a pitch between 50 and 75 degrees, the seam being from 5 feet to 7 feet thick?

ANS.—The ordinary method of working with batteries will probably give as good results as any if the details are properly carried out. The bottom of the breast is closed with heavy timbers set at right angles to the pitch against which the loose coal rests after it has been shot down. These timbers compose the battery and through an opening in them the coal is from time to time loaded into cars standing on the gangway. A continuation of the battery timbers is carried up both sides of the breast where they are planked to a height sufficient to prevent the coal rolling into a traveling way thus formed. If the seam is

gaseous the planking referred to is made continuous from roof to floor and as air-tight as possible, so that the ventilating current may be forced up to the face. The miner stands upon the loose coal while at work, and draws out enough from time to time through the battery, so that he may always be within convenient distance from the face. Steps should be provided in one or both of the traveling ways.

Ques. 33.—When the water gauge is 1.95 of an inch, what pressure per square foot does it indicate?

Ans.—Each inch of water gauge indicates a pressure of 5.2 pounds per square foot. The pressure per square foot when the water gauge reads 1.95 inches is therefore $1.95 \times 5.2 = 10.14$ pounds.

Ques. 34.—Suppose we have 30,000 cubic feet of air passing when the water gauge is 1.6 inches; what quantity will pass when the water gauge is 2.5 inches?

Ans.—The quantity of air in circulation varies as the square roots of the pressures as measured by the water gauge. Hence the quantity of air passing under the increased water gauge is found from the proportion, $\sqrt{1.6} : \sqrt{2.5} = 30{,}000 : x$, whence, $x = (30{,}000 \times .5) \div .4 = 37{,}500$ cubic feet.

Ques. 35.—How many horsepower in 825,000 units of work?

Ans.—A unit of work is the raising of 1 pound 1 foot high in 1 minute and 1 horsepower is equivalent to 33,000 such units. Hence, 825,000 units of work are equivalent to $825{,}000 \div 33{,}000 = 25$ horsepower.

Ques. 36.—An air-course is 1,000 yards long and is 7 feet high and 9 feet wide. What is the area, perimeter, and rubbing surface?

Ans.—The area is $7 \times 9 = 63$ square feet. The perimeter is $7 + 7 + 9 + 9 = 32$ feet. As the length of the airway is 1,000 yards = 3,000 feet, the rubbing surface is $3{,}000 \times 32 = 96{,}000$ square feet.

A 4-foot seam of anthracite was recently found 36 feet below the surface at the Court House square at Heber Springs, Ark.

PERSONALS

Harry M. White, who has been an engineer for the Pittsburg Coal Co., at Belle Vernon, Pa., was on June 1, promoted to superintendent of the Tremont and Arnold City mines of the company, vice Superintendent George Harkess, who was transferred to the Crescent mine, California, Pa.

J. T. Clark, of Suterville, Pa., in charge of electric work at Forest Hill and No. 5 mines of the Pittsburg Coal Co., has been made foreman of the Carnegie mine of the company.

R. C. Smith, for a number of years superintendent of Forest Hill mine of the Pittsburg Coal Co., has been promoted to the position of mine inspector.

D. A. Reese has been appointed receiver of the Buffalo Coal and Brick Co., owning coal land in Armstrong and Butler counties, Pa.

H. C. Hamilton, of Girard, Ill., has been appointed receiver for the Farmersville Coal Co., of Farmersville, Ill. The liabilities are given as $30,000.

The Temple Coal Co. was organized the first week in July. The president of the company is S. B. Thorne, who is also head of the firm of Thorne, Neale & Co., of Philadelphia. Frank H. Hemmelright, who has been in active charge of the collieries, has been elected vice-president and general manager and president of the subsidiary companies. He will continue to be the chief operating official, as heretofore. A. M. Bingham, who has been treasurer of the subsidiaries, is now secretary-treasurer of the Temple Coal Co. and the underlying companies, while Thomas Mead has been elected auditor, an office which he held under the old organization. The directors are S. B. Thorne, F. H. Hemmelright, George H. Frazer, James Brown, and J. Norman Ball.

Harry N. Taylor has resigned the presidency of the Monon Coal Co., and is succeeded by F. A. Delano, present head of the Monon Railroad and former receiver for the Wabash Railroad. Mr. Taylor, it is understood, will devote his entire attention to his various mining interests in Missouri and Indiana and to opening new properties in Iowa.

J. Edward Yoch, of the International Coal and Mining Co., Belleville, Ill., has been reelected treasurer of the Coal Operators' Association of the fifth and ninth districts of Illinois.

President W. K. Field, of the Pittsburg Coal Co., and his family, sailed recently on the Imperator for a 6 weeks vacation in Europe.

Edward Husband, Erskine Ramsay, J. E. Strong, W. S. Kahn, and J. D. Moore were appointed by Governor O'Neal, of Alabama, as members of the State Board of Examiners.

Joseph Edward Stubbs, for 20 years president of the University of Nevada, died at Reno, May 27, 1914.

A. G. Spillman, general superintendent of the St. Bernard Mining Co., Earlington, Ky., has been appointed by Governor McCreary as a member of the Board of Examiners, which under the new mine law of the state grants certificates to mine foremen.

C. M. Means, electrical engineer, of Pittsburg, Pa., has been appointed consulting electrical engineer with the United States Bureau of Mines.

J. R. Crowe, head of the Crowe Coal Co., operating mines at Pittsburg, Kans., will leave shortly for a tour of Europe and incidentally to visit some European mines.

Joseph Elwood, for several years with the Pittsburg and Midway Coal Co., at Pittsburg, Kans., has resigned to become general manager of the P. R. Sinclair Coal Co., of Aurora, Mo.

H. D. Mason, Jr., who has been in charge of the government mine rescue car at Pittsburg, Kans., for the past year, has been transferred temporarily to Pittsburg, Pa., succeeding J. W. Paul, mining engineer, who will leave shortly for an inspection tour of European mines.

The Summer School work in Mine Surveying at Lehigh University was held this year at Hazleton, Pa. The work consisted in surveying a portion of the Wharton coal seam, and 16 men took part. Besides the underground work, an opportunity was had to visit breakers and open-pit workings.

J. C. West, hitherto local manager at San Francisco for the Sullivan Machinery Co., has been transferred to the general offices at Chicago, in the capacity of general sales engineer. Ray P. McGrath, who for several years has been associated with the New England sales office of this company, at Boston, has been appointed district manager at San Francisco office, to fill the vacancy.

W. A. Thomas, for several years in charge of the sales of mining apparatus of the Westinghouse Electric and Mfg. Co., has resigned his position, and has opened offices in Pittsburg as a consulting engineer.

George Denny, of Peoria, Ill., has been appointed a member of the State Mine Rescue Commission by Governor Dunne, of that state, vice Stephen Wolschlag, deceased.

Otis Mouser has been elected vice-president of the Stonega Coke and Coal Co., in charge of sales and traffic matters.

Harry J. Marks, manager of the New York office of the American Engine and Electric Co., has been advanced to the position of sales manager of the company.

Alexander H. Tilley, of the *Ashland Evening Telegram*, delivered an instructive and interesting address at the closing exercises of the Lehigh Valley School of Mines at Centralia, Pa.

GEORGE B. MARKLE

George B. Markle, a well-known anthracite operator and member of the firm of G. B. Markle & Co., Hazleton, Pa., died recently from the effects of an operation. The firm of G. B. Markle & Co. was started many years ago by the father of the deceased, at Jeddo, Pa.

Catalogs Received

H. K. Porter Co., Pittsburg, Pa. Modern Compressed Air Locomotive, 80 pages.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. "Giant" Fuel Oil and Gas Engines, 11 pages; "Chicago Pneumatic" Gasoline and Fuel Oil Engine Driven Compressors, 15 pages.

Link-Belt Co., Chicago, Ill. Section "A" Catalog 110, The Original Ewart Detachable Link-Belt and Sprocket Wheels, 111 pages. Book No. 195, Link-Belt Newspaper Conveyers, 39 pages.

L. J. Wing Mfg. Co., 352-362 West 13th Street, New York, N. Y. Air Handling and Power Plant Machinery, Bulletin 17.

B. F. Sturtevant Co., Hyde Park, Boston, Mass. Catalog 210, Sturtevant Steam Turbines, 46 pages.

Webster Mfg. Co., Tiffin, Ohio. Webster Method, 72 pages.

John Davis & Son, (Derby) Ltd., Derby, England. No. 113 A, Anemometers, 43 pages: No. 114 A, Miners' Safety Lamps, 27 pages.

Mesta Machine Co., Pittsburg, Pa. Air Compressors and Vacuum Pumps, 8 pages.

General Electric Co., Schenectady, N. Y. Bulletin No. 47401, High Voltage Oil Break Switch for Outdoor Service, 8 pages; Push-Button Control, 15 pages.

Sullivan Machinery Co., Chicago, Ill. Core Drilling by Contract, 31 pages; Sullivan Rock Drill Mountings and Accessories, 35 pages; The Sullivan Channeler in Engineering Work, Bulletin 68 A, 15 pages; Sullivan Ironclad Coal Cutters, Bulletin 63M, 35 pages.

Western Electric Co., 463 West Street, New York, N. Y. Western Electric Inter-Phones and Accessories, 48 pages; The Making of the Voice Highways, 15 pages.

Jeffrey Mfg. Co., Columbus, Ohio, Circular, Jeffrey "Motorturret" Coal Cutters.

American Mine Door Co., Canton, Ohio. Mine Ventilation with the Canton Automatic Trap Doors and Signals, 56 pages.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin No. 34-N, Class "N" "Chicago Pneumatic" Steam and Power Driven Enclosed Compressors.

Marion Steam Shovel Co., Marion, Ohio. Stripping Coal with Economy and Speed, 40 pages.

New York Cement Gun Co., 30 Church Street, New York. The Cement-Gun, The Apparatus, Process, and Product, 106 pages.

William Graver Tank Works, Chicago, Ill. Bartlett-Graver Water Softner and Purifier, 47 pages.

Accident With Breathing Apparatus

In the Josef seam at the Consortium Ruben Pit, Neurode, which had on several occasions been the scene of outbursts of carbon dioxide, work was conducted with electrically fired blasts. A series of these, one only of which had gone off, had been fired on November 11, 1912, and, the detector lamps showing the presence of carbon dioxide, two men with breathing apparatus attempted to reach the place of working. When nearing the latter, one of them began to reel, and had first to be supported and afterwards to be dragged along by his comrade, whose strength ultimately failed him, so that he had to make his escape alone. The prostrate man was ultimately carried out, but did not recover. Experiments were made with the apparatus used, and professional opinions obtained as to the causes of its failure. It could only be surmised that the man, although well acquainted with the directions for using his breathing apparatus, must have put it on in a careless manner, not filled his nose properly with cotton wool, or had attempted to talk and thereby inhaled carbon dioxide. As a result of the accident, more stringent rules for the ventilation of workings in which the occurrence of carbon dioxide was to be expected were laid down.—*A. R. L. in Trans. I. M. E.*

57'

The Colliery Engineer

Formerly Mines and Minerals

Vol. XXXV—No. 2 SEPTEMBER, 1914 Scranton, Pa.

The Truesdale Colliery

The Largest Shipper of Anthracite. A History and Description of the Mine and Its Development

*By P. H. Devers**

THE Truesdale colliery is located in Hanover Township, about eight miles south of the city of Wilkes-Barre, Pa., along the Newport & Hanover branch of the Lackawanna Railroad. The development of these mines was begun in 1903, at which time the sinking of two rectangular shafts was started. The shafts are 14 ft. × 45 ft., inside, in section, and 560 feet in depth to the Ross beds. Both shafts are lined and divided into four compartments. Two 8′ 4″ compartments are for hoisting; one 8 ft. 4 in. is a pumpway, and one 14 ft. × 18 ft. is an airway. The two hoisting compartments in No. 1 shaft are separated from the airway by a 13-inch brick wall; in No. 2 shaft, however, a 13-inch concrete wall is used for the same purpose. Both walls have 4′×6′ blow-out panels placed 30 feet apart, which are closed by walls of one brick in thickness, their object being to protect the main walls in the event of an explosion of gas in the mine workings. In addition to the shafts the Truesdale colliery has three slopes from the surface and two 7′×12′ rock tunnel openings made necessary by the irregular pitch of the beds, and for the quick development of the mine. The Holland, or No. 1 tunnel, was driven many years ago and abandoned after some mining had been carried on in the Forge, Twin, Top Ross, Bottom Ross, Top, Middle, and Bottom Red Ash beds, which appeared near the surface on account of the Warrior Run anticline, that practically divides this property into two separate mining basins, at least so far as economical mining is concerned.

Fig. 1. Truesdale Breaker, the Largest Electric Coal Breaker in the World

The erection of the Truesdale breaker and washery was started in 1903; and the buildings completed and placed in operation November 15, 1905. The breaker is composed of structural steel to the top of the pockets, from there up it is of wooden construction, but the management intends to change the wood work to steel when repairs are needed, and then enclose the upper structure with wired glass. This improvement will make the Truesdale plant modern in every respect, in fact it was the second anthracite breaker which used electricity to

*Assistant District Superintendent D., L. & W. Coal Co.

drive the machinery, the first being the Auchincloss belonging to the same company. The electric current cycles, over high-tension lines, to a large substation at the colliery mines, where it is passed through volts, direct current, to operate locomotives. The electric current is conducted into the mine workings

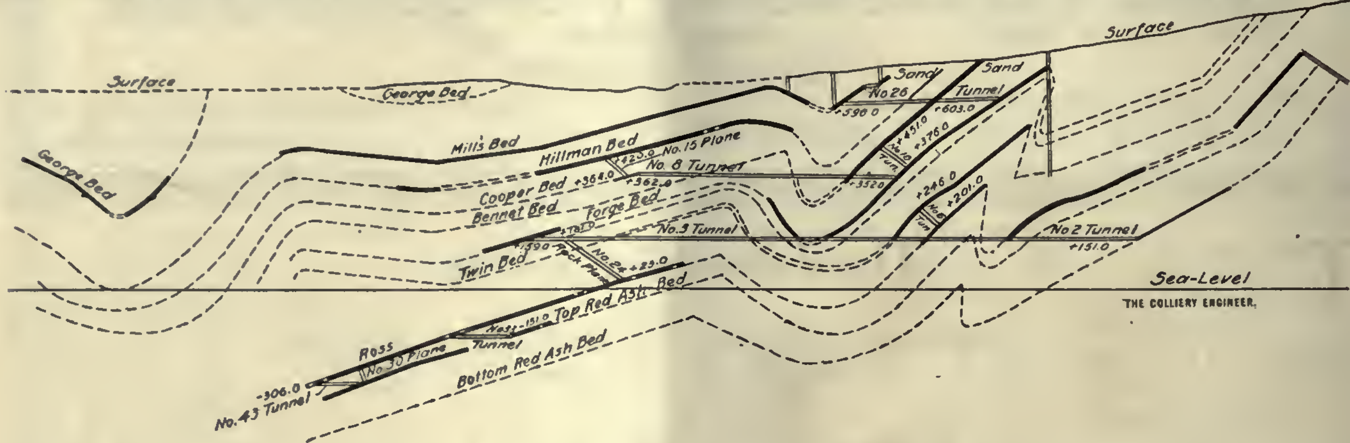


FIG. 2. SECTION ON LINE OF NO. 3 TUNNEL, TRUESDALE COLLIERY

for this plant is generated at the second central electric power station used at coal mines in this country, the first being installed at Keyser Valley, near Scranton, by the same company. The power station is about 3 miles from the Truesdale mines and has recently been enlarged to meet the new demands made for power by the sinking of Loomis shafts.

The electric current is conducted at 4,150 volts, three-phase, 60 several 300-kilowatt oil-cooled transformers and reduced to 440 volts, three-phase, 60-cycle, current to operate the machinery in the breaker. Each machine, such as rolls, screens, elevators, etc., is driven separately by 440-volt, alternating-current motors of the induction type, of various horsepower. The substation is also equipped with a 500-kilowatt rotary converter and a motor-generator set. The power is passed from these machines at 250 at 4,150 volts, three-phase, 60-cycle, alternating current, by the use of armored cables suspended in the pump compartments in the shafts, encased in 6-inch wrought pipe; also cables are suspended in 6-inch bore holes, drilled from the surface at convenient points. From the shafts, or bore holes, the current is conducted by the same kind of cables, along the gangway roads, in a fiber conduit encased in concrete, to a fireproof concrete transformer room.

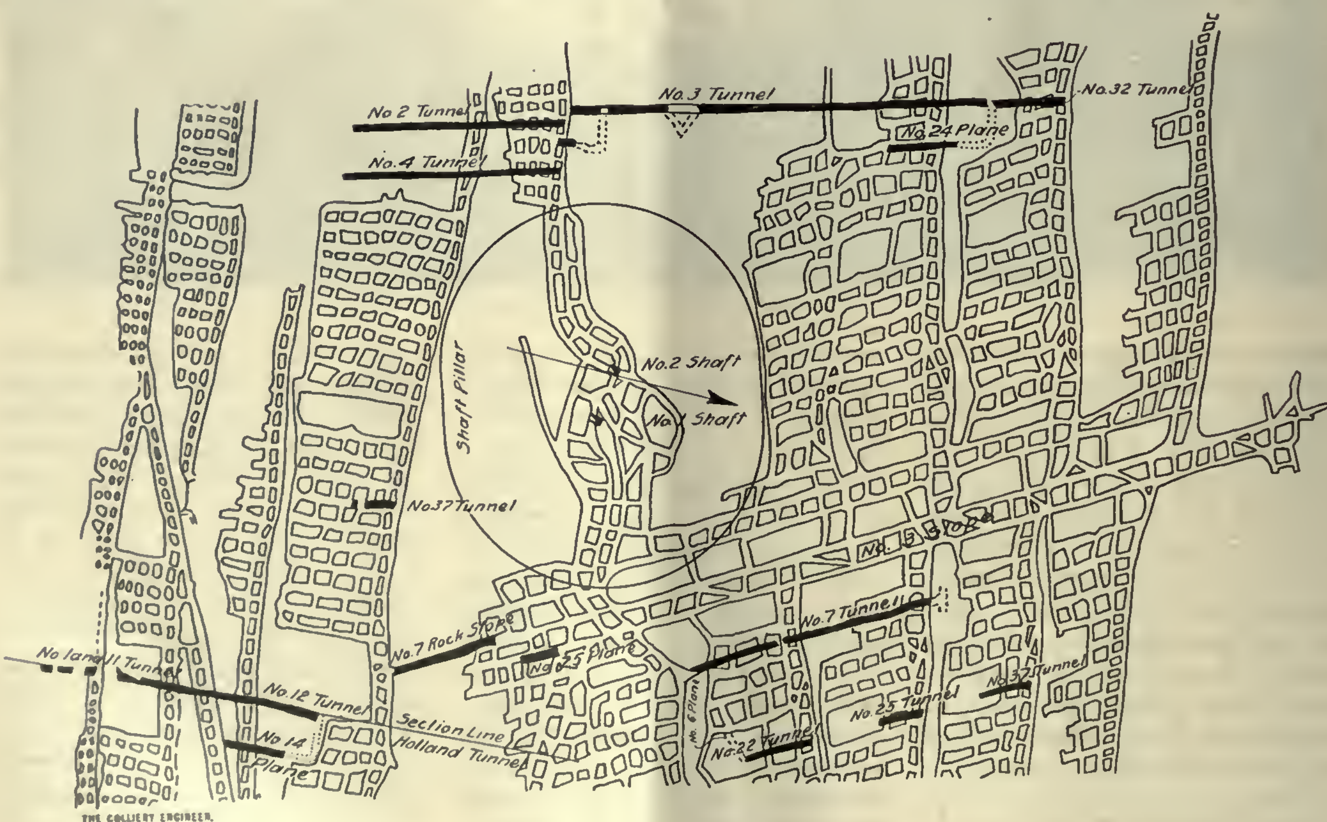


FIG. 3. PLAN OF TRUESDALE MINE

This room is equipped with several 300-kilowatt oil-cooled transformers, which step the voltage down to 440 alternating current, and at this pressure it is sent to various sections of the mines, in the same manner in order to operate pumps, hoists, etc. The transformer room has a direct outlet connection to the main return airway of the mines in order to protect the employes in case of fire, and the smoke from it can be sent direct to the up-cast shaft, by the use of doors which can be operated from the inlet by means of a steel rope and pulleys. The 250-volt direct current is conducted within the mine excavations by the same methods, but at various points it is connected direct to the trolley wires. The cables are laid in 600-foot sections, and at the end of each a concrete manhole is provided, so that all splices can be readily made at these points, in the event of trouble, such as a short circuit, ground, etc. All cable splices have wiped soldered connections.

Development.—The several openings were provided for the purpose of rushing the development and to concentrate the general scheme of mining. The Holland tunnel in which is located No. 2 slope on the Ross bed, is one of the oldest mine openings in the Wyoming coal field. The history of it is as follows: Samuel Holland, one of the pioneer operators, bought land in Hanover Township in 1838 for coal mining purposes. He bought the John B. Garrison, Sterling, and the Shoemaker properties, at the rate of $25 per acre, the land being so poor for farming purposes that the owners were glad to sell even at this low figure. This was the first land ever sold or bought in Hanover Township for the purpose of coal mining. In 1840, Holland opened a 7 ft. × 12 ft. × 1,000 ft. tunnel which passed through the seams before referred to, all of them at an angle of 45 degrees from the horizontal. During the same year he had constructed a narrow-gauge railroad from his mines to the old Dundee basin on the Susquehanna River, 2.1 miles from his mines. At this basin the coal was loaded into "arks" and transported to Baltimore, Md. The narrow-gauge railroad on its way to the basin passed about 300 feet west of the Dundee shaft, which is at present being reopened and widened in connection with the development of the New Loomis colliery. The first criminal executed in Luzerne County was put to death for the murder of the rock contractor at the portal of this Holland tunnel.

All the coal seams which are now being developed vary in pitch from horizontal to vertical. The coal is all blasted from the solid and is very gaseous, and this condition makes it imperative to use safety lamps and Monobel powder in many sections of the mines. In all the steep pitching seams, the chambers are being worked full and paid for by the yard, the surplus coal only being loaded out until the chambers reach their respective mining limits. Then the coal is drawn out and loaded by day men called "company loaders."

Fig. 4. Method of Timbering Horizontal Chambers, Truesdale Mine

Fig. 5. Chamber Adjoining the One Shown in Fig. 4. Note Difference in Work

In some cases the dividing rock is but 4 feet thick between the top and bottom Ross seams, and in these sections the chambers are worked by the yard full of coal, by the rock-chute system, the workings in each seam being kept by the means of careful surveys in the same vertical plane.

The coal measures are very much broken by slip faults, one of which drops the various seams, vertically 250 feet. Local synclinals and anticlinals frequently occur which necessitates a large amount of tunnel work as shown in the section, Fig. 2. The tunnels in some instances pass through one seam as many as three times on grade. The main slopes are all developed on the four-entry system, the advantage being that two inlets and two return airways are provided. One inlet is used for haulage, and the other for a manway.

Air bridges of concrete construc-

tion are erected across each lift. These gangways are located on the slope 350 feet apart. The ventilation is so arranged that any lift or group can be provided for separately, or the entire current can be concentrated to any desired point in case of emergency. The ventilation is produced by the following different kinds of fans:

Two 25-foot diameter Vulcan Guibal fans which are run at 75 revolutions per minute and produce a 3-inch water gauge.

One 7′ × 16′ Jeffrey Guibal fan which runs at 90 revolutions and produces a 2.6-inch water gauge; and one 7′ × 12′ Jeffrey Guibal fan which runs at a speed of 145 revolutions per minute and produces a 2.5-inch water gauge. In addition to these fans there are two 5′ × 12′ open running fans driven by 40-horsepower motors equipped with silent-chain drives.

The other fans are driven by steam engines of the Corliss and slide-valve type. The coal is transported by the use of 13- to 15-ton main haul, 250-volt electric locomotives, and the gathering is done with 7-ton locomotives equipped with crab and reel of the General Electric and Jeffrey makes. The mine car weighs about 3,000 pounds empty and is hauled to the face of all chambers, except when the grade of track exceeds 16 degrees. On grades of 8 degrees or less the locomotive hauls the cars to the working faces, but in all chambers when the grade is greater than 8 degrees the mine cars are hauled to the face by the locomotive using a ¾-inch steel rope. This rope is passed over a 20-inch angle pulley on the gangway and around a 20-inch sheave wheel fastened to a prop located in the center of the track at the face of each chamber. The cars when loaded are let down the chamber grades by use of the locomotive and ¾-inch ropes.

Fig. 6. Electric Hoist, No. 4 Slope, Truesdale Mine

Fig. 7. Head of No. 3 Slope, Truesdale Mine

During the year 1913, the Truesdale colliery prepared and shipped to market 1,089,610.11 tons. In addition to this, 4,373.07 tons was prepared in the Truesdale breaker for the Avondale mines, 36,000 tons was consumed at the colliery plant for fuel, 500 tons was kept in the breaker pockets for emergency use, thus making the total preparation 1,129,983.18 tons. This remarkable record gives to the Truesdale plant the proud distinction of being the first anthracite colliery to prepare and ship to market 1,000,000 tons or over in any one year.

It has required 96 years of development in the anthracite field, or from 1807, the year in which the first shipments of anthracite were made by floating the 10-ton "arks" down the Susquehanna River, until 1913, with our modern railroad facilities for transporting the product of the mines to tide water and inland cities, in order to obtain results such as these.

Coal Mining in Illinois

There are two districts in Illinois where a combination of explosive gas and coal dust in the mines render mining operations very dangerous unless proper precautions are taken for the prevention of explosions. One of these is District No. 5 comprising Saline and Gallatin counties, in which there are 33 mines. Bulletin 6, Coal Mining Practice in District No. 5, by S. O. Andros, issued by the Illinois Coal Mining Investigations, discusses safety measures that are considered necessary in this district and gives data on the mining methods there used.

The per cent. of fatal accidents caused by explosions is 32.1 for this district as compared with 2.9 for the state as a whole. Each employe produces an average of 5.1 tons of coal per working day while the average daily production per employe for Illinois is 4.5 tons. This high per capita production is due to the extensive use of mining machines; 90.2 per cent. of the tonnage of the state being mined by machines.

The district is characterized geologically by an igneous dike which penetrates the coal bed and in places extends through the bed into the overlying strata.

Copies of the bulletin may be obtained upon request from the Illinois Coal Mining Investigations, Urbana, Ill.

Practical Coal Mining

Methods of Working, Ventilation and Transportation in Bituminous Coal Mining

*By Thomas A. Mather**

Coal mines are opened to produce coal as economically as possible (and cheaper than that if possible). A man's ability and success is measured largely by the economic production and the preservation or future welfare of the property, rather than by the quantity.

You can take a good mine, and produce cheap coal for a time, by cutting off all development work, making no improvements and neglecting the general maintenance; then like the crops on the neglected farm, the output will gradually decrease, the cost per ton increase because of the decreased tonnage, and it will take years to put the mine back again to the same paying basis.

Today a great many of the larger coal companies run their mines from an engineering standpoint, and of course, also some of the smaller concerns. The practical men of the mines today realize to a greater extent their need of technical training, than do the technically trained men realize the necessity of a thorough practical knowledge of the art of mining. After you have been in the mining game a few years this statement will come home to you with much stronger force. Taking up the subject of practical coal mining I will first consider the advantages of working the coal on the face cleats instead of on the end cleats. The advantages are as follows: An increase of production per employe; less explosives required; better marketable coal produced; less timber required for the removal of pillars; greater yield of coal per acre.

An increased production per employe can be accomplished by laying out the system of mining so that the greatest amount of work can be obtained from the least amount of labor expended. In coal seams where the cleavage planes are well defined and the face and end slips are pronounced, it is possible to plan the work so that a great efficiency can be obtained from the men's labor. Take for example two different sections of the same mine, in one section the rooms are driven on the end cleats, and in the other the rooms are driven on the face cleats. Those men working in the face places will produce from 12 to 15 per cent. more coal with the same amount of labor, than will the men working places driven on the end cleats. This means that the earning power of the men has been increased from 12 to 15 per cent. without increasing the price paid per ton, car or bushel, as the case may be, but rather by more efficient methods of mining. By this means the daily output is increased in the same proportion and the earning power of the employes as well.

Now it may be possible that this increased tonnage can be handled without any additional cost for transportation, particularly if the mine has modern improvements and the coal is gathered by motors able to take care of the increased tonnage. Assuming, however, that it requires more help to gather and haul this coal from the face to the shaft or to the tipple, yet even then the cost for transportation will not be greater than before. The company men such as the cagers, road men, pump men, brattice men, rock men, timber men, trappers, and inside officials, the hoisting engineer, firemen, dumpers, topmen, weigh boss, car trimmers, blacksmith, carpenter, clerks, foremen, superintendent, and outside officials, are needed whether the tonnage is increased or not. Now the cost per ton for all these different classes of labor will be inversely as the increased tonnage produced by the greater efficiency of the men working in places being driven face on.

Relative to the second advantage, it may be stated that rooms driven on the face require from 25 to 40 per cent. less explosives to blast the same amount of coal. If the top be smooth, a shot on each rib is sufficient usually to bring down the coal across the entire place, while in an end room, from 3 to 5 shots are required to do the same work. This is a saving, not only in explosives, but in the time that it takes to drill, tamp, and fire these additional shots.

It can be understood that coal which is easily brought down, will stand handling much better than coal badly shattered by blasting and that thus a better marketable coal is obtained.

In retreating with the pillars that are worked on the face, the fall can be made more frequent and the weight removed from the place and the standing timbers, besides a better marketable coal not crushed by the weight is obtained. It requires more space to make falls in end-on places, and with the cleats running parallel to the rooms the falls usually extend down the roadways, breaking the road and gob props, which necessitates more timbers to be set and possibly to replace those broken.

The last advantage of working face on is that a greater amount of coal is obtained per acre. For a number of years a great deal has been said about the conservation of our coal resources and some very ridiculous statements have been made in this connection. In the year of 1911 about 500,000,000 tons of coal were mined in the United States; a statement was made and widely circulated by a person of national prominence that in producing this amount of coal some 500,000,000 tons were lost. Now with the room-and-pillar system, which is almost entirely used throughout this country, from 45 to 55 per cent. of the coal is taken out in the first mining (that is, in the rooms) and if only 50 per cent. of the remaining pillars are recovered this would

*Inspector 18th Bituminous District, Pa. Lecture delivered at the Pennsylvania State College Mining Institute to the students.

make 75 per cent. of the entire bed. This estimate is very low for some sections of the bituminous coal fields, and no doubt too low for the general average of the state of Pennsylvania. However, there is too much coal lost in extracting the pillars, and by far the greatest percentage is lost in pillars retreating end on.

As stated, it requires more space to make falls in the end places, with the cleats running parallel with the rooms. The falls, when made do not break off at the face of the pillar but extend down the roadway of the room, usually burying a portion of the pillar and making it too dangerous to recover. All this is avoided in pillars retreating face on.

An ideal method of working is the panel system, each panel being about 1,000 to 1,200 feet square with rooms driven face on. This method eliminates long productive entries, i. e., the entries from which the rooms are turned off, which are driven frequently 3,000 or 4,000 feet long. Often in the double-entry room-and-pillar system by the time the chain pillars are ready to be pulled (and sometimes before) the timbering has decayed and must be replaced; besides, entries are in such wretched condition that it costs at times more to keep them open than the coal recovered is worth. All of this can be avoided with the panel system, where the short entries are driven up and the retreating completed before the entries get in bad shape.

I have been somewhat surprised that there has not been a demand before now for men who have specialized along the lines of mine ventilation. Coming events cast their shadows before, and in the October, 1913, issue of The Colliery Engineer this advertisement appeared: "Wanted mining engineer having expert knowledge of mine ventilation, must be capable of examining a mine and recommending the best system of ventilation, must be familiar with the common mine fan designs."

I do not know just how deep you go into the technical part of this subject, but I do know that there is a great deal of difference between calculating the size of fan required to produce a certain quantity of air with a given water gauge and the practical distribution of the air through the working places in the mine.

How many of you are aware that in the average mine in Pennsylvania from 2½ to 4 times more weight in air is forced in every 24 hours than is taken out in coal. This may seem like a very radical statement but it is nevertheless true. The bituminous mine laws require 150 cubic feet of air per minute for each person employed in the non-gaseous mines and 200 cubic feet per minute in gaseous mines, and as much more in either case as the mine inspector may deem requisite. Let us take 200 cubic feet per minute per 24-hour day as an example:

$$\frac{200\times60\times24\times.0766}{2,000}=11.03 \text{ tons.}$$

The average production for each employe inside the mine for 1911 was 935 tons, assuming they work an average of only 200 days during the year which is very low, it makes the daily average of 4.6 tons which divided into $\frac{11.03}{4.6}=2.4$ times the weight of air, to the weight of coal loaded. Now the law requires this amount of air to be effective at the face of the workings, but the average amount of air effective at face is not over 60 per cent. of the total volume in circulation. Here is an opportunity for greater efficiency in mine ventilation.

Many young engineers, and many old practical miners as well, make the mistake of taking one of the natural laws governing the flow of air through mines, and expecting it to fit some particular case they have in mind without considering all of the other factors which also govern the flow of air in mines. For instance take as an example 40,000 cubic feet of air per minute passing through an airway 6 ft. × 8 ft. in cross-sectional area with a water gauge of 1.2 inches, what quantity will pass through an airway 8 ft. × 12 ft. in cross-sectional area where the pressure and the lengths of the airways are the same. From the equation $q=a\sqrt{\frac{pa}{klo}}$ reduced to $q=a\sqrt{\frac{a}{o}}$ the following proportion is derived:

$$\sqrt{\frac{48^3}{28}} : \sqrt{\frac{96^3}{40}}=40,000 : x \text{ and } x=94,649.$$

But we have overlooked one very important factor, for if we were at a mine where there was a volume of air equal to 40,000 cubic feet and we wish to increase it to between 90,000 and 100,000 cubic feet we might be deluded into thinking that by enlarging the airway to twice the size we would get the desired results. If you made the change on this basis you would not get what you expected, for if the mine is ventilated by a fan you would be unable to increase its speed to get the desired results, because the engine driving the fan is running at its capacity and you could get no increased power from it.

In order therefore to get 94,649 cubic feet of air through the 8′ × 12′ airway there must be greater power, because the pressure per square foot is the same in each case and power equals $\frac{pq}{33,000}$, then in the first case we have $\frac{1\times40,000}{33,000}$ and in the second case $\frac{1\times94,649}{33,000}$ which is practically 2⅓ times the power in the first instance. By the enlargement of the airway a good, substantial gain was made; for example, take the same problem except the power remains the same, then the quantity of air will be directly proportional to the area and inversely proportional to the cube root of the resisting surface—then $\frac{48}{\sqrt[3]{40}} : \frac{96}{\sqrt[3]{28}} :: 40,000 : x$ and x equals 71,032 cubic feet.

Now let us take another problem which will better illustrate the point at issue. If there are 10,000 cubic feet of air passing through a mine

in one current, the resistance of the shafts at the time being the same as that of the mine, what extra quantity will pass by adding another airway of the same dimension as the first, power remaining the same? The units of work required to pass 10,000 cubic feet through the shafts and one airway are expressed by the formula

$$u=\frac{ksq^3}{a^3}=\frac{.00000001\times 48{,}000\times 10{,}000^3}{36^3}$$

= 10,288 units of work. After making two airways of the same dimensions as the first, the velocity in the shaft will be double that of the airways. The pressure or units of work will vary as the square of the velocity, then $1^2 : 2^2$, the units of work available for resistance of the shaft, equal $\frac{4}{5}$ of the total 10,288 or 8,230.4 units, and quantity of air that will pass through a shaft with these units is

$$\sqrt[3]{\frac{u}{ks}}\times a=\sqrt[3]{\frac{8{,}230.4}{.00000001\times 24{,}000}}\times 36$$

= 11,692 cubic feet.

The point I wish to bring out is that in practice you must always consider the shaft resistance as an important factor in your calculations. Assume the first problem applies to a drift mine, although the problem is not practical since there are nearly 100,000 cubic feet of air and in all probability there would be four to five splits or separate air-currents to consider. It is not practical to have these splits made right at the ventilator and usually the volume of air is carried in one current for 1,000 to 1,500 feet before splits are made, then this length of airway acts just like a shaft, and to double the quantity it takes four times the pressure and eight times the power for this single airway, and whenever changes are made with the power remaining constant the shaft resistance plays an important part.

Why does not a ventilating fan when changed from one mine to another give the same volume of air with the same water gauge? Every mine has what is known as an equivalent orifice, the area of which equals an area made in a thin plate, the resistance of which is equal to the resistance of the mine with the same volume of air passing through this area as passes through the mine at the same pressure that is producing the ventilation. As every fan has an equivalent orifice, a comparison is made of the results obtained at two different mines, with the same fan.

The equivalent orifice of the fan at one mine equals 30 square feet and the equivalent orifice of the mine equals 20 square feet. Now if the velocity of the fan equals 1 and the velocity of the mine air equals 1.5 since the pressure varies as the square of the velocity then the pressure for the fan equals 1^2 or 1 pound and pressure of the mine equals 1.5^2 or 2.25 pounds. The efficiency equals $\frac{2.25\times 100}{2.25+1}=69.2$ per cent. At the other mine the equivalent orifice of the fan is 30 square feet, the equivalent orifice of the mine is 16 square feet and the velocity of air through the orifice of the mine equals 1.875, then the pressure for fan equals 1^2 or 1, and the pressure for the mine equals 1.875^2 or 3.51. The efficiency of fan equals $\frac{3.51\times 100}{3.51+1}=77.8$ per cent.

From these data quite a difference in air volume, in water gauge, and in power is found, because if the volume is the same the water gauge is much higher, and the power greater. Assume that the fan in the first case gave 80,000 cubic feet of air per minute, with a 3-inch water gauge, then $\frac{3\times 5.2\times 80{,}000}{33{,}000}=37.8$ horsepower.

If in the second case the equivalent orifice is 16 square feet now for 80,000 cubic feet of air the velocity will be in the ratio of $\frac{20}{16}$ or 1.25 and since the pressure varies as the square of the velocity, then 1.25^2 equals 1.56 inches water gauge and 3×1.56 equals 4.68 inches water gauge, therefore $\frac{4.98\times 5.2\times 80{,}000}{33{,}000}$ = 59 horsepower.

In comparing efficiency the power must be the same in each case, therefore what quantity will pass through the 16-foot orifice? Applying the quantity formula $\frac{20}{\sqrt[3]{16}}:\frac{16}{\sqrt[3]{18}}::80{,}000:x$ and x equals 66,560 cubic feet. The pressure is $\frac{1{,}248{,}000}{66{,}560}$ or $\frac{18.72}{5.2}$ pounds, i. e., the water guage is 3.6 inches. The efficiency of the fan in the second case is $\frac{66{,}560\times 100}{80{,}000}$ or 83.2 per cent.

After all it is the effective ventilation at the face of the working that counts, good substantial air stoppings, elimination of doors as far as possible to insure at all times a constant and adequate supply of pure air to render harmless the noxious gases being given off, and to keep the mine in a healthy and sanitary condition.

The theory of mine ventilation is essential as it enables one to calculate beforehand the results that should be obtained from any change made in the system of ventilation; and from the moments of resistance that a mine offers for a given quantity of air one can determine the size of the fan necessary to produce that quantity and the horsepower that it will require to maintain it.

TRANSPORTATION

The transportation of coal from the working face to the tipple is the largest single item of expense that the operator has to stand, except of course, the price paid the miner for loading and mining the coal; and as this is usually agreed upon by representatives of the operators and miners it is not under the control of the practical officials at the mine.

The transportation of coal in the mines is railroading on a small scale; the railroad engineer can determine beforehand what grade he is going to have on a piece of road before it is built, but the inclination of the coal seam fixes the grade for a mining engineer and usually that grade is very irregular. A system that may be ideal for part of the distance in the mine sometimes cannot be used at all in the remainder of the mine.

Today the mines are using electric, compressed-air, and gasoline motors. The electric locomotives are also equipped for handling the car in the rooms, some being equipped with a cable which if attached to the trolley wire permits the motor to go to the face of the working places for the loaded cars; in other instances the locomotive is equipped with a drum, operated by a separate electric motor on which is coiled a small steel rope about ¼ inch in diameter. A locomotive with this equipment stays on the entry while the brakeman takes the steel rope to the face of the working place and attaches it to the loaded car which is then pulled out by operating the drum on the locomotive. This last system is hard work for the brakeman, especially if it is a low seam of coal.

The electric locomotive has advantages over the other locomotives mentioned. The main and the tail-rope haulage is the most flexible and economic system of haulage; since it can be used on level roads, on roads with a small pitch, or on roads where grades alternate and relatively high pitches occur. One cannot imagine any ordinary conditions existing in a mine on which a main and tail-rope system cannot be installed. Of course there are electric hoists for pulling out of dip workings and electrically driven engines for operating main and tail-rope haulage, but this is the old system with a new power applied.

It is essential that a good road bed be kept in a mine, well drained, and above all sufficiently large pillars must be left to protect the main haulage roads. The greatest mistake in mining has been due to leaving pillars of insufficient size for the protection of the main haulage roads and airways.

In May the Guyandotte River collieries of Logan County, W. Va., shipped 530,000 tons of coal, thus for the first time passing the half-million-ton mark. Fifty-four collieries were involved in these shipments.

Mine at Panama-Pacific Exposition

At the request of various mine operators and the exposition officials, the United States Bureau of Mines has undertaken to construct, in cooperation with the mining industry and the manufacturers of mining machinery, a mine beneath the floor of the Palace of Mines and Metallurgy at the Panama-Pacific Exposition.

The financial and operative success of the mine is assured through exhibits promised as shown below whereby typical metal and coal mining operations will be produced by full size working places in which mining machinery will be installed and operated. The walls of the mine will be covered with either ore or coal typical of the mine illustrated. Among others, the Copper Queen Consolidated, of Arizona; Bunker Hill Sullivan Co., of Idaho; Homestake Mining Co., of South Dakota; Goldfield Consolidated Mines Co., of Nevada; Jones and Laughlin Co., of Michigan; Lehigh Coal and Navigation Co., of the anthracite field of Pennsylvania; Pocahontas Fuel Co., of West Virginia; Consolidation Coal Co., of Kentucky, and Pacific Coast Coal Co., of Washington, have each agreed to reproduce one of their working places or stopes and to contribute the sum necessary to the installation and operation. Tentative promises of similar action have been received from the Rock Island Coal Co., Peabody Coal Co., and Pittsburg Coal Co.

Various mining machinery and appliances have been promised, including a mine cage and cars by the Joshua Hendy Co.; a cage, hoist, and motor, by the Denver Engineering Works; locomotives by the Westinghouse Electric and Mfg. Co.; pumps by Byron Jackson; air compressor, drills, drill sharpener, and winze hoist, by the Compressed Air Machinery Co.; drills and coal cutters by the Ingersoll-Rand Co. and the Sullivan Machinery Co.; lamps by the Justrite Mfg. Co. and the Koehler Mfg. Co.; enamel signs by Stonehouse Enamel Sign Co. There is little doubt that other necessary machinery and appliances such as safety lamps, portable electric lamps, fan, mine telephones, mine rescue apparatus, switches, track, etc., will be received as exhibits.

The entrance to the mine will be through the Bureau of Mines space, and visitors will be attracted to it by being given portable mine lamps, and by being lowered in a very slowly moving cage while a panoramic effect of the strata lining a mine shaft will pass by them so rapidly as to produce the illusion of descending to a considerable depth. In case of crowds, these may enter by a slope.

There will be a motion-picture room which visitors will pass in going from mine to mine. In it will be shown such great open workings as are not illustrated by the underground mines, such as those of the Utah Copper Co. and those of the Nevada Consolidated Co. at Ely, the iron diggings at Hibbing, Minn., hydraulic gold mining, and the quarrying of building stone.

Twice each day there will be an imaginary explosion or fire in some portion of the mine announced by telephone to the superintendent's office in the Bureau of Mines space on the surface, and rescue men wearing breathing apparatus will enter the mine and bring out supposed victims who will be given first-aid treatment in the surface emergency hospital.

In the Bureau of Mines space on the floor of the main building there will be, in addition to the radium booths, exhibits of carnotite, pitchblende, and other radium ores, their alloys and concentrates, an emergency mine hospital and smoke room for rescue training, exhibits of fuel efficiency, smoke abatement, explosives, mine welfare work, etc.

The prime purpose of the mines will be that of educating the investing public, stockholders, members of legislatures and the uninformed relative to the importance of the mining industry, its extent, variety, and the cost of operation.

The J. K. Dering Coal Co.

A Description of the New Operation of That Company at Mine No. 1, Near Clinton, Indiana

By William Z. Price

TWO miles south of Clinton, Ind., on the Chicago & Eastern Illinois Railroad, is the new No. 1 mine of the J. K. Dering Coal Co. The seam worked at this mine is the No. 3, and measures 6 feet in thickness. The structure of the coal is banded, it has good cubical cleavage and an irregular fracture. In hardness, this coal like other bituminous coals of Indiana occupies a medium position among soft or bituminous coals of the United States. No analysis of the coal at this mine was available, but an ultimate analysis of average Indiana coal shows as follows: Carbon, 61; hydrogen, 5.5; oxygen, 18; nitrogen, 1.1; sulphur, 3; ash, 11.4.

The shaft is 227 feet deep, passing through the old Oak Hill workings of the No. 5 seam 57 feet below the surface. The bottom of the shaft is situated on a small anticlinal and it was necessary to take up 18 feet of rock at the shaft bottom when grading for the cage room and main entries.

OUTSIDE FEATURES AT MINE NO. 1, DERING COAL CO.

The coal is worked in panels by the room-and-pillar system. The panels measure 300 ft. × 675 ft. with 150-foot rooms. Entries are driven within 50 feet of the next cross-entry, the coal is then worked out on both sides and the entries abandoned before they require extensive repairs. This system eliminates the expense of keeping up numerous long roads. After entries are abandoned they are walled up with concrete along the main haulageway.

The rooms are driven 22 feet wide on 35-foot centers and a recovery of about 80 per cent. is expected. The coal is undercut by Sullivan continuous coal cutters. An interesting feature of the underground workings is the extensive use of concrete by the company. In the plan of workings near the shaft bottom shown on page 68, some parts completed and others nearing completion, the cross-hatched area indicates that part concreted to date. The average section of these roadways shows vertical walls 4½ feet high on either side and 9 feet apart. The roof is arched to these walls, its highest point being about 8½ feet above the roadway.

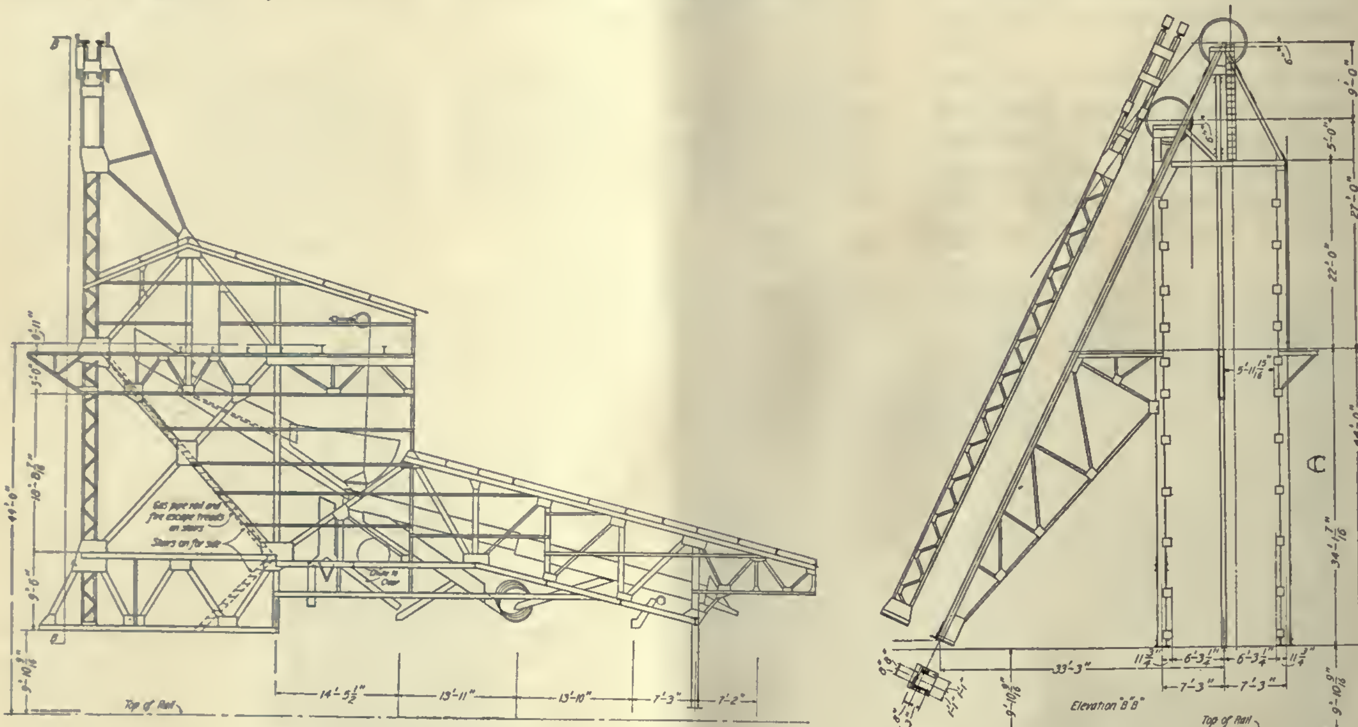
Several exceptions, however, exist to this general section. Along the roadway approaching the shaft, for a distance of 300 feet the walls

are 16 feet apart, continuing this width to the other side of the shaft and up the empty car haul, where it widens out to 20 feet for a short distance. 2,240 cubic yards of concrete gravel (natural mixture) were used with one barrel of cement per cubic yard of gravel.

No timbering is allowed on any of the main entries, the company thus following the same idea as the Steel Corporation at their Gary mines. Poor roof is avoided by leaving up 1 foot of top coal.

When the empty cars leave the cage at the foot of the shaft they run on to an empty car haul or endless-chain drag which takes them to the top of a short incline, from which point they run to a kick-back and are then shunted right or left as desired.

The method of sending the cars in either direction at this point is highly interesting. The points of the latches are connected by an iron rod which extends on either side of the track to electromagnets. These magnets are operated by a man at the shaft bottom. He throws an electric switch right or left and the magnets pull the points of the latches in the direction desired. When the car starts to one side from the kick-back it strikes a lever which lights an electric lamp at the shaft bottom; as it rounds the curve to the empty car storage track it trips another lever which extinguishes the lamp. Thus, in case the bottom man notes the light being on too long he knows that the car is off the track somewhere between those points and will send the following cars to the track on the other side. This plan eliminates several extra men. It is the present plan of the company to install electric contact switches on the empty car storage tracks so that a light will indicate when the trip of cars reaches a certain length and then the future cars can be sent to the track on the other side.



Side and End Elevation of Tipple at Mine No. 1, Dering Coal Co.

Drag Handling Empty Cars

The steel tipple is of Allen & Garcia Co. patented design, and the shaking screens and conveyer are electrically driven by small motors. The following description of this type of tipple is given by Mr. Garcia.

Instead of putting columns at the corners of the shaft, two main columns are placed in the middle of the concrete curbing at each end of the shaft just back of the guides, the guides themselves being carried directly by, or bracketed from, these columns. The center guides are also carried by a vertical column directly between them, this column being hung from the main structure, so as not to rest on the buntons, and bracketed at several points so as to have ample lateral and longitudinal stiffness. When adapted to an end hoist tower, the sheaves are carried directly on a frame of the same width as the column, the forward leg of which is carried down to the


Buildings at Mine No. 1, Dering Coal Co.


View of Tipple Looking South


Tipple and Mine Buildings, Mine No. 1


Caging Cars at Bottom of Shaft


View from Bottom of Shaft

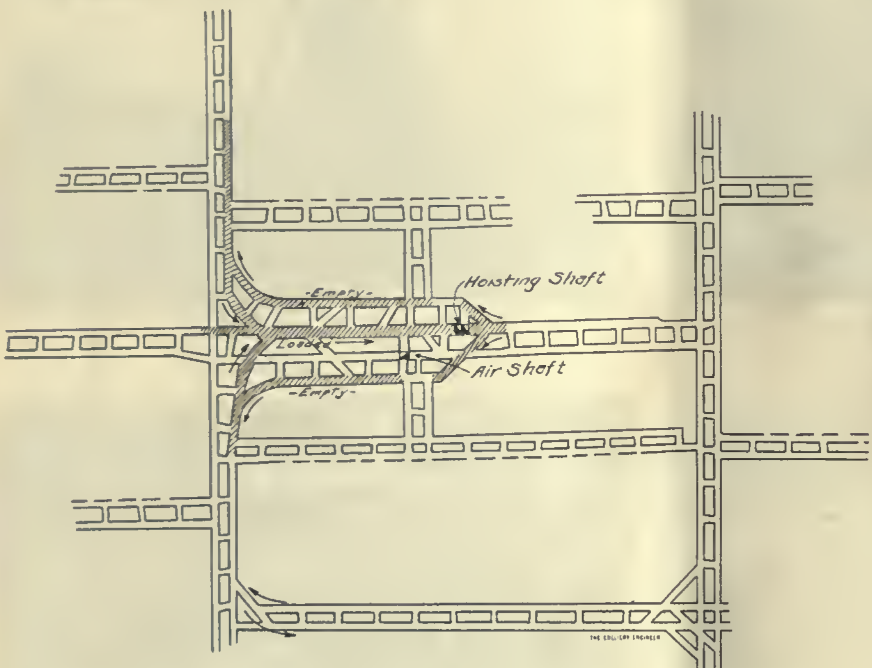

Top of Empty-Car Haul

ground in a line outside of the resultant of the cable stress. All columns are made of such width as will insure sufficient lateral rigidity when supported throughout their length, and to carry the journal bearings of the sheaves.

The main structure, carrying the weigh house and screens, is built over the tracks at right angles to the hoisting frame and designed so as to give the greatest possible rigidity to the tower and to carry the shock of dumping directly to the ground.

With this construction it is an easy matter to design a screen structure so stiff that the vibration of the screen will have little or no effect upon it, and the screens can then be hung on properly journaled, rigid hangers, so as to operate with only a fraction of the friction and wear incident to roller bearings. The eccentrics or other operating mechanism for the screens, may then be supported on cross-members so that any vibration from them will be absorbed before being communicated to the main structure.

The advantages of this construction are as follows: The main tower is composed of three heavy and substantial members which can be encased in concrete so as to protect them entirely against accident or corrosion. The weight and cost of the main tower, in spite of its great strength and rigidity, is scarcely two-thirds that of a properly designed A-frame tower. The shaft is left entirely clear at the bottom of the tower, so that rails and other material can be easily loaded on the cages. The foundations are cheapened and cut down in number, also a screening structure of sufficient stiffness is built and rigidly connected to the main structure. Finally the guides are attached direct to the tower columns and form a stiff rigid slide for the cages from the shaft collar to dumping point, all at a less cost than former style of construction.



Plan of Workings Near Shaft Bottom

In working out the details of this tipple, it became necessary to make a careful analysis of the action and operation of the screens. The first requirement was to design the screens so that they would be as nearly balanced as possible under the varying conditions of load. This can usually be accomplished by making the upper section of the screen, which receives the coal directly from the weigh pan, somewhat shorter and lighter than the lower section. Then, in studying the forces acting upon the screen through the driving rods, it became evident that it was possible to devise a very much better operating mechanism than the time-honored eccentric, so a bell-crank was substituted, and operated by driving rods from two large flywheels which perfectly balance the two sides of the screen. The power factor is thus made so constant that the motor or engine can be direct-connected to this shaft, and as the whole mechanism is self-contained, the resulting vibration is very small. The driving rods have journal bearings arranged for thorough lubrication, and the ratio of lever arms is such that the forces are reduced to one-quarter before reaching the driving rods and the flywheels.

The other features outside comprise the electric hoist and the fan. Every machine about the plant is electrically driven. The power is supplied by the Terre Haute, Indianapolis & Eastern Traction Co. at a metered current charge (with a sliding scale), the power company being guaranteed a minimum bill.

The current as received at the mine is three-phase alternating current at 22,000 volts, which is stepped down to 2,200 volts by three 300-kilowatt Westinghouse transformers for the electric hoist and the motor-generator set. The hoist is a product of the Ottumwa Iron Works and has a 5-foot cylindrical drum; it is driven by a 300-horsepower General Electric induction motor.

A 10-foot Jeffrey fan is installed at the mine. It has a capacity of 100,000 cubic feet per minute and is geared to a 40-horsepower General Electric two-speed motor. The motor has an adjustable base in order to put on larger pinions to increase the speed. Noiseless running is a result of using rawhide pinions. The motor-generator set is of General Electric design and converts the alternating current into direct at 250 volts, which is utilized principally by the coal cutting machines. As the workings enlarge, another set will be installed for furnishing power for electric locomotives.

This is the first all electrically operated coal mine in Indiana.

The High Shaft Mine

At Steubenville, Ohio—One of the Oldest Shaft Mines in the State but Operated by Modern Methods

*By Wilbur Greeley Burroughs**

THE High Shaft coal mine of the Steubenville Coal and Mining Co., said to be one of the oldest shaft coal mines in the state, having been opened in 1857, is located near the heart of the business section of Steubenville, Jefferson County, Ohio. There are no railroad connections with the tipple, the coal being delivered from the tipple into wagons, chiefly for local use. The coal mined lies 225 feet beneath the surface. Exactly what name to give this coal seam has been rather an open question, some geologists and mining men holding that it is the Upper Freeport seam of the Allegheny series Pennsylvanian system, while others maintain that it is the Lower Freeport seam. The findings of I. C. White, State Geologist of West Virginia, as stated by that geologist to the writer, are as follows: "I would say that our Survey determinations of the age of the Steubenville Shaft coal agree with those of the late Professor Orton (State Geologist of Ohio); that is, that it represents the Lower Freeport or 'Rogers' of the Ohio Valley, and not the Upper Freeport as the late Professor Newberry thought it did. I do not think there can be any doubt that the bed in question represents the Lower Freeport coal, since it has been traced by the drill as far south as Wheeling. The Upper Freeport seems to disappear as a workable bed along the Ohio River everywhere between Wheeling and the Pennsylvania state line."

W. T. Griswold, in the County Report of the West Virginia Geological Survey, describes this Lower Freeport coal seam for the region in general, as follows: "Where this coal is mined by shafts in the vicinity of Brilliant, Steubenville, and other points above Wheeling, the bottom portion of the bed, 8 to 14 inches in thickness, is often rejected, and frequently separated when mined, since it is high in sulphur, while the average in the coal above the bottom member is usually less than 1 per cent. A thin parting of slate generally separates the bottom member from the main portion of the seam above, so that the upper and purer portion of this coal can be readily mined independent of the basal division. It is in the lower bench that the variation in thickness of the seam is found."

At the Steubenville Coal and Mining Co.'s mine, a section of the Lower Freeport coal seam is as follows:

Shale	
Sandstone	40 to 50 feet
Shale	15 to 20 feet
Upper bench of coal	42 inches
Slate parting	2 inches
Lower bench of coal	7 to 14 inches

A sample analysis of Lower Freeport coal, in general, is given in the County Report of the West Virginia Geological Survey, by G. P. Grimsley, as follows:

	Proximate Analysis Per Cent.
Moisture	1.05
Volatile matter	36.00
Fixed carbon	54.86
Ash	8.09
	100.00
Sulphur, per cent.	2.6
Phosphorus, per cent.	.008

	Ultimate Analysis Per Cent.
Carbon	75.27
Hydrogen	5.56
Oxygen	8.23
Nitrogen	1.18
Sulphur	1.67
Ash	8.09
	100.00
Calorimeter B. T. U.	13,819
Calorimeter B. T. U.	13,820

The sulphur comes principally from the coal of the lower bench.

W. T. Griswold has estimated that "the Steubenville quadrangle (including the areas in Pennsylvania, West Virginia, and Ohio), contains 320,590,000 tons of Pittsburg coal; 189,890,000 tons of Rogers (Lower Freeport) coal; and 17,474,000 tons of Finley coal, a total of 527,954,000 tons."

At the mine of the Steubenville Coal and Mining Co. the coal is reached by a hoisting shaft, 7 ft. × 14 ft. inside dimensions, and 225 feet deep. For 72 feet downwards from the surface, the shaft passes through clay, which is soft and runny, ground water continually keeping it in this condition; the shaft, however, next passes into firm shale and sandstone, which form walls that stand well, require scarcely any timbering, and with which no trouble has ever been experienced.

The portion of the shaft passing through the soft clay originally was timbered, but as concrete lining was deemed more desirable, a concrete lining 2 feet thick was put down in the following manner: The shaft timbers could not be removed from the bottom upwards, as once removed the shaft would have caved in. Therefore, sections of concrete, 5 feet to 6 feet high, were placed at a time, and sunk by removing from under the concrete shell about 30 inches vertically of the old shaft timbers, which having been accomplished, the concrete shell would sink 30 inches, when it would be stopped by shaft timbers as yet untouched. This operation was repeated throughout the entire 72 feet to the solid bed rock. By this method the sides of the shaft were everywhere reenforced, and all danger of caving was prevented.

In mining, the room-and-pillar system is used, with double entries, 9 feet wide and 6 feet high, separated by a 30-foot pillar of coal, driven approximately on the face and butt cleats.

The main haulage entry runs north and south from the bottom of the hoisting shaft. Butt entries are turned east and west every 500 feet. From the butt entries face entries

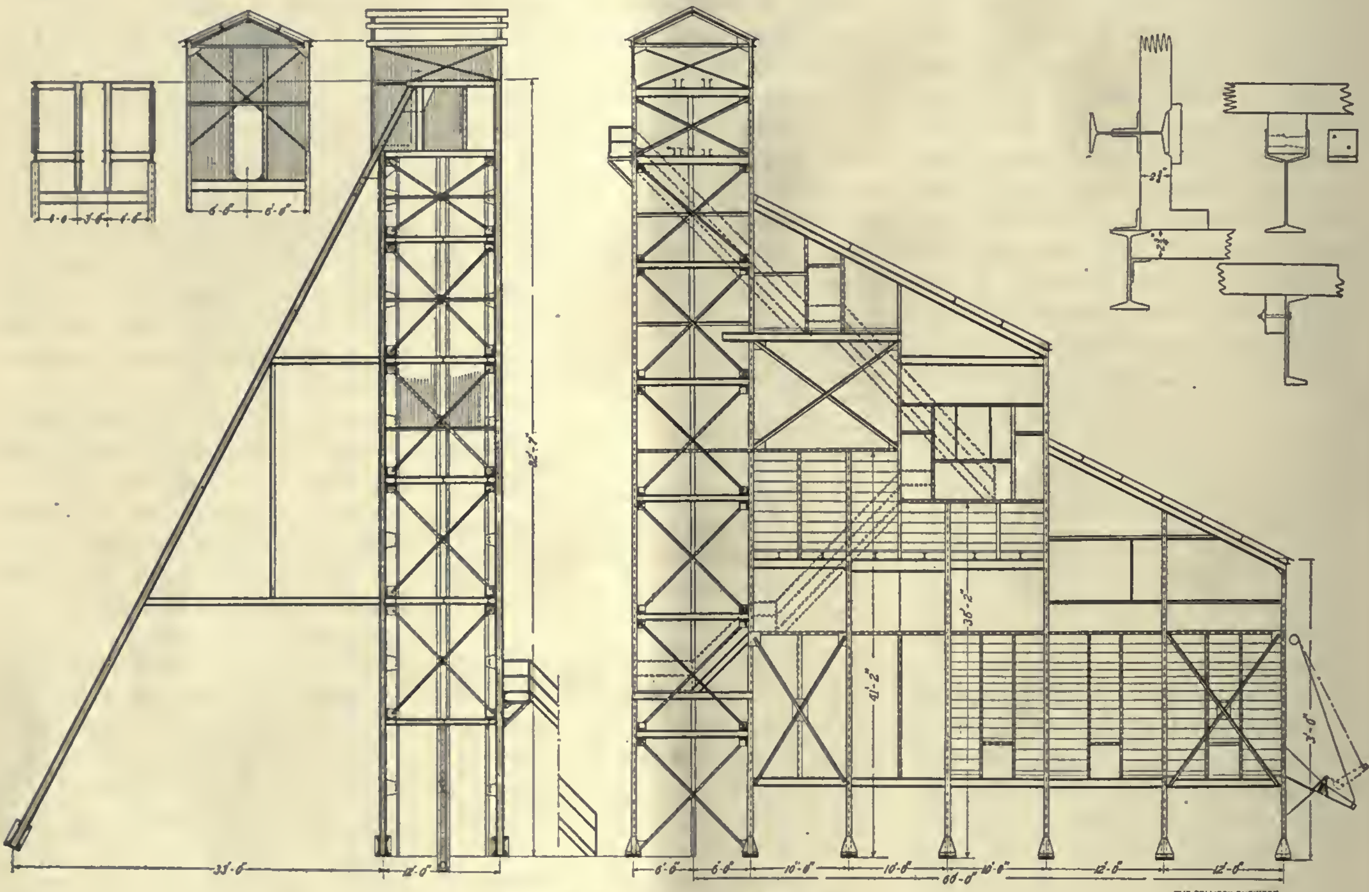
*Oberlin, Ohio.

are turned every 250 feet, which makes the face entries run north and south. The rooms turned, generally full width, from the butt entries, have a north and south direction. They are 22 feet wide, 6 feet high, 250 feet long, and have 42-foot centers, which leaves a 20-foot pillar of coal between the rooms. Breakthroughs are made every 60 feet between the entries, and every 60 feet between the rooms, but in the latter case are staggered.

The coal is mined by four Morgan-Gardner electrically operated mining machines.

All haulage in the mine is done by electricity. The heaviest grade is between 2½ per cent. and 3 per cent. against the loaded trip. For haulage, there is one Morgan-Gardner 7½-ton electric mine locomotive, and one General Electric electric mine locomotive.

The ventilation is accomplished by means of a 12-foot steam exhaust fan; and in the mine near the working face, one Robinson 42-inch electric force fan. The air-shaft, 8 ft. × 16 ft., 180 feet deep, with stairway, is three-fourths of a mile north of the hoisting shaft. In the mine, door regulators, and some overcasts are used.



Elevations of Tipple at High Shaft Mine

Not much water accumulates in the mine, and a Deming 5-horsepower electric pump, suffices to keep the workings dry.

The coal in the loaded trip on reaching the bottom of the main shaft is hoisted from the mine on a self-dumping cage which is considered to be one of the smallest self-dumping cages ever installed in this region. This cage, which was manufactured by the Connellsville Mfg. and Mine Supply Co., is 4 feet ½ inch face to face of cage guides, and operates on the 8-inch face of the guide timber. The length of the platform of the cage is 5 feet 7 inches. The cage is fitted complete with safety dogs and safety chains of the same design as the larger cages manufactured by the same company, and a general detail of the floor, arms for holding the car on the cage, and the tipping arrangement is the same as that of the larger cages.

Above the hoisting shaft rises a steel head-frame and steel tipple, as shown, designed by Geo. S. Baton & Co., of Pittsburg, Pa., and erected during the winter of 1913-1914. In the design the idea followed throughout was to arrange bins and screens so as to deliver three grades of coal to the wagons with the least possible expense of operation.

At the tipping floor the coal is dumped into a concentrating chute, and then passed over a 1¼-inch bar screen, the lump being discharged from the weigh basket, into which it was delivered, through chutes into the main lump bin. The slack and nut that passed through the 1¼-inch bar screen are passed over a ¾-inch screen which separates the slack from the nut, each being conducted by chutes into the upper slack bin and upper nut bin. From the upper

slack bin and upper nut bin the coal is conveyed to the lower slack bin and lower nut bin by vertical chutes. From these lower bins the coal is fed into wagons for distribution, the slack being discharged from the bins by a flat bin slide in the bottom of the bin. The nut and lump coal are discharged through the sides of the bin over small rescreens into wagons stationed below. By passing the coal over the rescreen it is made clean when loaded into the wagons for local delivery. The slack coal from the small rescreen is conducted by a chute to a drag conveyer situated on the surface of the ground beneath the tipple. The drag conveyer delivers this slack coal to a bucket elevator which lifts and delivers it into the slack bin.

The general layout is arranged so that a car can be installed to run on a track at the elevation of the top of the lower bins for taking the three grades of coal to a storage pile; the car receiving the slack and nut coal from a slide in the bottom of the upper bins, and the lump coal over a by-pass in the screening equipment. The car is to run at the end of the tipple on a steel trestle that has not as yet been placed.

In a new brick building is located the power plant which consists of two 150-horsepower Erie Iron Works boilers with Murphy automatic stokers; and in another room, separated from the boilers by a brick wall, is a Skinner automatic engine driving a 100-kilowatt Morgan-Gardner generator which suffices for the operation of the mine's electrical equipment. The hoisting is accomplished by means of a pair of Crawford & McCrimmon, 18″ × 32″ direct acting steam hoisting engines which have recently been installed.

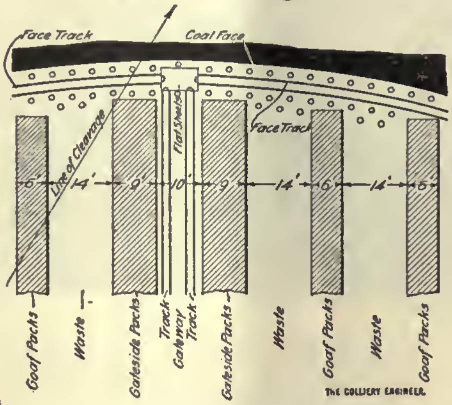
For the greater part of the information contained in this article regarding the Steubenville Coal and Mining Co.'s High Shaft property, the writer is indebted to Ebenezer Jones, superintendent; and for drawings and additional information to Geo. S. Baton & Co., Pittsburg.

Bentley Colliery

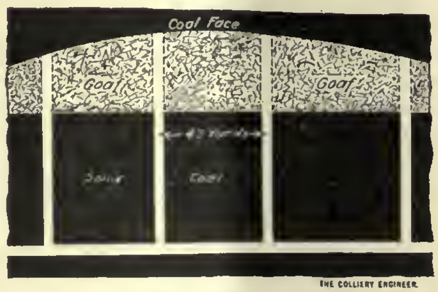
A Description of the Conditions and Methods of Working in the Doncaster Area of Yorkshire, England

By Samuel Deon

BENTLEY is one of the large new collieries in the Doncaster area of Yorkshire. The famous "Barnsley" bed is worked, the depth of the shafts being 1,950 feet. The seam averages 5 feet in



Longwall Mining



Opening Longwall Face

thickness and is worked longwall advancing. The output averages 4,000 tons per day, one shaft, 14½ hours hoisting. The following is an average section and shows the nature of the roof:

		Feet	Inches
Blue shale		20	0
Soft shale		2	0
Top coal		1	6
Soft shale with coal streaks		3	0
Soft coal		4	0
Soft friable slate	Seam worked at the face	0	6
The Barnsley Seam:			
Hard coal		2	6
Soft coal		2	6
Dirt		0	2
Hard slate floor			

The gateways are from 120 to 150 feet apart, and the cross-gates 360 feet. On account of the tender nature of the roof the roads have to be frequently brushed and the packs are soon buried. The pressure of the roof at the face makes the coal very easy to dig and shot firing is not necessary. The method of haulage on the main roads is endless rope, and on the secondary roads main rope by small compressed-air engines; horses are also used. Accompanying sketches show the method of operation at the face, showing the gateway (two tracks), packs, props, and face tracks.

Systematic timbering is employed, the props being spaced 5 feet apart, both ways, with good cap pieces. The greatest distance allowed from the face to line of props is 5 feet. Temporary props are set when necessary. The timbering is in line and kept straight with the face. Only three lines of props are kept at the face, and all back props are withdrawn by means of the Sylvester machine. This is a hard and fast rule, as the mine is subject to gob fires and gives off much gas, a bad combination; and timbers left in the goaf aid in starting a gob fire. All props are tapered at the bottom to reduce the diameter to about half the original diameter.

This lengthens the life of the prop and prevents it from breaking in the middle, as the weight settles and brooms the pointed end. The packs are kept up as near the face as possible. The gateside packs are 9 feet wide, the goaf packs 6 feet wide with 14-foot wastes. The roof bends down from the face on to the packs, and falls seldom occur at the face. It is possible to travel round one line of face a distance of 5,940 feet. The writer traveled several hundred yards of face and saw no falls. One of the most interesting pieces of information which he received from the managers was that an 1,800-foot face is considered a short one, and that they would have difficulty in working a face of this length. They have much difficulty in holding the roof when they are starting out a face. And not until they have a

face 2,000 feet long with a goaf of 300 feet behind them do they get free from roof troubles at the face. They prepare for the dreaded "first weight" by close packing, and after they get further away they can take more liberties with the roof. The crush of the first weight travels back over the narrow work for 200 or 300 feet.

Bentley Colliery

The gauge of the track is 26 inches, the weight of the rails on main roads 28 pounds to the yard, and in gateways and on the face 18 pounds to the yard. The cars stand 3 feet 4 inches above the rail and hold 14¾ hundredweights of coal. It is strange that the car capacity has not been increased in the north of England, and the Midlands. The general equipment of the new collieries is magnificent in every way, but there is no reason why larger cars, heavier rails, and compressed-air locomotives should not be introduced. There are three miners and three laborers—six men—to each 120 feet of face. The miners are paid a hewing or tonnage rate of 48 cents a long ton and pay their own laborers a day wage of $2.04 for 8 hours. They do their own packing, this being included in the 48-cent rate, and are paid 18 cents for unloading each car of rock sent into the face. The miners do their own brushing in the gateways and pack the rock—all included in the 48-cent rate. When they are paid 18 cents a car for unloading rock it is from falls back from the face. From this it will be seen that the miners dig the coal, timber the roof, do their own brushing and packing, and lay their own track at the face for 48 cents a long ton. The average per shift for all men employed at the face is 5 tons—this includes miners and their laborers, showing that the miners are averaging close to $3 a day for 8 hours. In this connection it must be remembered that the roof weight acts as a lever at the face and makes the coal very easy to dig. Great slabs of coal are pried off the face by means of long iron bars, in fact it may be said that the coal nearly digs itself. The face is kept at an angle of about 45 degrees with the line of cleavage, or is nearly half-end and face. The faces are never allowed to get in advance of each other. The selling price of run-of-mine coal, or the average for all grades was $2.50 a ton last year; it is not surprising, therefore, that dividends of 20 per cent. and 30 per cent. on the common stock are usual in South Yorkshire. As is well known, coal mining is far more profitable in Europe than it is in the United States, and although the unions are strong on the other side of the Atlantic there is less antagonism shown toward what is called "capital." Lloyd George keeps up his attacks on the dukes and landlords, but corporations are certainly not being attacked as severely as they have been attacked in the United States, and strong libel laws prevent the press from printing malicious untruths. After an absence from the country of a few years, one notices an increase in the cost of living, and Lloyd George is receiving the blame for this.

Double-gauze Marsaut type safety lamps are used at Bentley, and Ceag and Oldham electric lamps are also used. As yet, electric lamps are far from being perfect, and the life of the battery is not more than 4 months, but the future will doubtless see great improvements. There is some talk of the new type of oil safety lamp, which gives a much improved light, displacing the electric lamp at the face.


Undermanager's House, Bentley Colliery (Position Equivalent to Mine Foreman)

All the haulageways, returns, and gateways, are stone dusted to prevent explosions of coal dust. The

shale dust is ground in a new Robey mill from the soft shale above the top coal. Shale of a soft light color only is used and care taken that no shale containing crystalline silica is included. The shale dust is sent down the pit in cars. The roadway to be dusted is first cleaned up by shoveling the dust off the floor. Shale dust is then thrown by shovelfuls on to the sides and roof until they have a white appearance; about 100 pounds of shale dust to the linear yard of roadway is used as the first dressing. The cost of sorting and grinding the shale dust, including depreciation of the plant, is about $1 per ton. The cost of transporting and applying the shale dust is about $2.30 per ton. The sampling of the dust has been done very systematically, in fact more so than has probably been done at any other colliery.

Miners' Houses, Bentley Colliery

Manager's House, (Position Equivalent to Mine Superintendent)

Table 1, compiled by Mr. R. Clive, gives some idea of the quantity and quality of dust at the face.

There is not much dust deposited on the haulage roads because the endless rope travels slowly, and the cars, being of steel, without end doors, are dust tight; further, the coal is not loaded above the top of the cars. The management of this colliery considers the roads and returns to be in a thoroughly safe condition with the average percentage of ash in the fine dust between 50 and 60 per cent., or just over one of coal dust to one of stone dust. The writer sees no reason, however, why the percentage of stone dust should not be higher, even than Table 2 shows, and this could be maintained by the introduction of shelves.

It is well to give here a statement by Mr. Geo. S. Rice, who has found at Bruceton that with a mixed dust containing 50 per cent. of ash, propagation of an explosion could not be obtained with a starting explosion of coal dust in a zone 100 feet long, but when the coal dust zone was lengthened to 300 feet, so that the pressure was high, propagation continued through a mixed dust zone 800 feet long, containing 50 per cent. ash, the flame going about 150 feet beyond, though not issuing from the portal.

The officials and workmen at Bentley are provided with beautiful homes as the accompanying photographs will show.

The writer is under obligations to J. W. Fryer, general manager, for information in this article and for courtesies shown during his visit to the colliery.

The Northern Colorado Coal Co., a Wyoming corporation with headquarters at Tyrone, Pa., has been sued by the Federal Government for a cancelation of the patents by which the company holds 1,280 acres of land in Colorado. A corporation is permitted only to patent 640 acres of government land under the Federal statutes.

A number of persons acted as dummies for the coal company, it is alleged, and procured the land from the Government. Then they transferred it to the corporation, according to the charges of the Federal authorities.

The deeds by which the land was conveyed to the coal company have been introduced as evidence in the case, and several of the original patentees have been placed on the stand. The coal company enters the defense that it purchased the land in good faith, and that it made no agreement with the holders before the patents were issued.

Table 1

Description	Fineness Per Cent.	Ounces Per Cubic Foot Area	Percentage of Ash
Passing through 10/30 mesh sieve	65.2	5.26	47.6
Passing through 30/60 mesh sieve	20.5	1.65	46.4
Passing through 60/90 mesh sieve	5.5	.44	47.8
Passing through 90/200 mesh sieve	3.5	.28	46.9
Through 200 mesh sieve	5.0	.40	43.7

Table 2

District	No. of Samples Taken From			Average Percentage of Dust Passing Through a 90-mesh Sieve			Average Percentage of Ash in Dust Passing Through a 90-mesh Sieve		
	Floor	Sides	Roof	Floor	Sides	Roof	Floor	Sides	Roof
All districts	104	101	28	25.84	33.33	47.43	64.00	71.53	65.30

Percentage of ash in dust passing through a 90-mesh sieve: average for the whole mine (total of 233 samples), 67.46.

Compensation Laws

History of Their Development—Advantages and Disadvantages of the Different Plans in Use in Various States

*By David Ross**

During the last few years more than a score of American states have by law substituted in lieu of legal procedure the principle of compensation in all cases involving industrial accidents. In determining under this plan the amount to be paid in any given case the questions whether the victim knew of the danger and therefore assumed the chances of being injured, or whether through his carelessness he contributed to the cause of the accident, or if it were the result of the unexpected act of some fellow employe, is not taken into consideration. All of these questions which, in most instances under former practice, constituted grounds for successful legal defense, are eliminated. In all these enactments or, in these contracts for laws—as their acceptance with a few exceptions is optional both with employer and employe—the employer without question agrees to pay and the employe to accept a specified amount in full satisfaction of all claims for damages. The only questions that may cause controversy relate to the time lost on account of accident, nature of the injury whether real or pretended, or if received in the line of or arising out of the employment. While American experience with these matters is limited, some complicated cases involving these issues have been passed upon by the courts or by state commission where that agency of adjustment is provided. In this, like all new industrial legislation, certain representatives of the employing or property holding class are inclined to consider the agitation for compensation revolutionary with confiscation as its ultimate purpose.

The idea that an employer with or without the sanction of the constitution, could be held to a financial accountability without fault on his part to respond in damages for an accident occurring to one of his employes was regarded as the latest anarchistic assault upon the rights of property and of the principles of a free government. This complaint was by no means confined to the industrial interests whose agents in most cases had no time to reason out its philosophy, but found potent expression from judges and lawyers, the galleries of whose minds were clogged and cobwebbed with the musty precedents in the past. We had become so accustomed to the waste of time and money in litigation over the claims of injured workmen that the proposition of agreeing to the sums to be paid in the event and in advance of an accident struck many as being preposterous and impossible. I do not wish to be understood as asserting that any considerable number of employers or members of the legal profession assumed this attitude; on the contrary, many able attorneys whose incomes are affected by this new plan of settlement, and numerous broad-minded employers of labor were among the most enthusiastic in their efforts to have equitable compensation laws enacted.

Contrary to common belief, the principle of compensation for industrial accidents is neither new nor revolutionary. Among the early acts of the American Congress was one requiring the owners of vessels in the United States to pay into a fund, controlled by the government, a fixed sum for the benefit of sick and disabled seamen, regardless of the fact whether or not the master or owner making payments had any sick or disabled seamen to take advantage of such funds. Whilst this policy would seem to run counter to the "due process" clause, no one has ever questioned the power of Congress under the constitution to pass such laws.

The same principle is affirmed in the statutes holding railroad corporations responsible for destruction of property caused by fire and for injuries to passengers, regardless of negligence or fault; also laws holding landlords liable for losses resulting from intoxication caused by sale of liquor by their lessees. These and many other like enactments have from time to time been considered and approved by the highest courts of the country. In the matter of state workmen's compensation laws, the questions of their constitutionality have been passed upon by five different supreme courts, and with one exception all sustained.

Thirty-two years ago the Federal Congress passed a compensation law limited to certain employes in the Life Saving Service. The act covers accidents and diseases and for a limited period provides full payment. This was the first specific act recognizing the responsibility of the United States for accidents and other disabilities occurring to those employed in the public service. Since then laws have been enacted extending the protection of such legislation to workmen engaged in other departments of the government service. Fully one hundred thousand, or one-fourth of the number employed in the Federal service, are in this way taken care of, and there is now pending in Congress a measure designed to cover and protect every one of Uncle Sam's employes. This measure was drafted and recommended for passage by the American Association for Labor Legislation, whose members constitute an important part of our citizenship. In enacting such laws we are but following the example of European countries, some of which began these reforms three-quarters of a century ago. It is rather a remarkable coincidence that the year after the famous decision of the English Lord Abinger, in the case of Priestly *vs.* Fowler,

*Abstract of an address by David Ross, representing the Department of Publicity of the Aetna Life Insurance Co., delivered before the session of the Illinois Mining Institute at Peoria, May 16, 1914.

1837, which for the first time announced the doctrines of assumed risk and fellow servant and which became a part of American common law, the kingdom of Prussia amended its law of negligence. This was the beginning of the new legislation relating to employers' liability, and as a result every European country has substituted the law of compensation for that of negligence.

In our own country the work of modifying employers' liability acts and rulings dates as far back as 1855, when Georgia passed a law abolishing the fellow-servant defense as applying to railroads. This was followed by similar action on the part of several states, some of them extending to all employments and including a repeal of the defense of assumed risk. From this it will be noted that for a long while the American people were getting ready to repudiate the theory of the common law as expressed in the rule of negligence and which explains the apparent hasty and general acceptance of the compensation plan.

There are now in operation several different kinds of compensation laws in the United States—the elective and compulsory, or the direct and indirect. In the first classification the difference is more apparent than real, as a refusal to accept the elective law carries with it the losses of the main defenses, which in a measure makes it compulsory. Practically the same purpose is accomplished in a different, and in my opinion, in a better way. The employer who is obliged to exercise a choice and who from conviction agrees to pay compensation rather than take chances with the law, becomes a convert to the plan and his cooperation in its success is thereby assured. Under this system he is liable for and agrees to indemnify his injured workmen direct for a certain specific amount, which in turn has the effect of increasing his interest and efforts in the way of accident prevention, thus reducing his financial obligations, admittedly superior to the indirect plan which consists in collecting a premium or tax from the industry, based on the pay roll of each plant, paid into a general fund and administered by state officials. Of the twenty-three states thus far adopting compensation laws, only a few are compulsory, operating mainly under the indirect method, and there is nothing in the experience of those states justifying its continuance or warranting its adoption by other states. In the administration of compensation laws, particularly where state commissions are charged with that work, very much depends upon the form in which the option is expressed. Unfortunately in most states operating under the direct elective plan, only that class of employers rejecting the act are required to file notice to that effect, those declining to do so or taking no action either way are presumed to accept it.

It is quite difficult under such procedure to ascertain who are really under the law and impossible to determine whether those thus automatically brought within its scope are responsible, and financially able to discharge the obligations which it imposes. If workmen in the event of an injury surrender their right to sue for damages, every precaution should be taken to make certain the payment of the amount of compensation due them and this cannot be done under any law where the method of election furnishes a record only of the class of employers rejecting it.

Advocates of compulsory laws base their contention on the assumption that to give to employers and employes an option whether they will accept or not defeats the purpose of uniform operation which is the object of all sound legislation, besides in a competitive way gives some an advantage over others. Theoretically, this would seem to be true, but it is not sustained by the facts. The optional act of this state has been accepted by fully 95 per cent. of the employers to whom it applies, the remaining 5 per cent. representing principally large employers who are quite able to meet any judgments that may be rendered against them. In the state of Michigan where the law, unlike ours, requires a written notice from all agreeing to accept its provisions, between 90 and 95 per cent. of all industrial workers are now in receipt of its benefits and, with the certainty of payments provided under the plan in force in that state, workmen are much better protected than they could be under a compulsory act, and this brings us to a consideration of

METHODS OF INSURANCE

The Illinois Act, Section 26 (*a*), provides four plans; first, the filing of a statement with the industrial board indicating financial ability to pay; second, furnishing security, indemnity or bond guaranteeing the payment of compensation; third, insuring liability in some company authorized to do an insurance business in the state; and fourth, to make some other provisions to assure the payment of compensation.

These requirements are common to the elective laws of many other states, the difficulty being in states, like our own, where the law brings everybody in except those filing notices to the contrary, to locate the employers subject to the law, as there is no way to list or check them except through the receipt of the report of accidents to their workmen, a duty that is frequently neglected. This obstacle is overcome in the administration of the Michigan law which, as stated, requires a written notice in advance from all employers accepting its terms. This supplies the necessary register and enables the commission to make provision for insuring the payment of compensation. The Michigan act provides four plans: self-insurance, corresponding with one of the provisions of our law, insurance with the state, or in stock and mutual companies. Employers can select which of these different methods of insurance they will adopt. I attended a conference last month at Lansing at which were members of commissions from various states having compen-

sation laws, and what most impressed every one was the general indorsement given the Michigan plan. It includes every interest in any way effected by its operation. This testimony came from the governor, the officials of the State Federation of Labor, the officers of manufacturing associations, insurance agents of every company doing business there, and even lawyers, some of whom had lost business on account of it. It is a rare occurrence for any legislative act to receive such unanimous approval and a matter of regret that we have not had the same active and enthusiastic cooperation in all other compensation states.

Regarding the much discussed question of insurance, the law there has placed the state in open competition with private companies for business. It has not, however, as in some of the states, notably Washington and Ohio, attempted a monopoly; but leaves the field free to all competitors, and in fact rather encourages an impartial test to determine which is the better plan; a policy that appeals to every one's sense of fairness.

It ought to be the privilege of every employer to select the kind of insurance he thinks best, and as to the question of cost he has to pay, a matter which does not primarily concern the injured workmen who must look to him or the company carrying his liability for compensation. Although a number of smaller and a few of the larger employers have taken out insurance with the state under the Michigan plan, they represent but a small per cent. of the total insurance written in that state, most of it by stock companies. And this brings us to the question why, with the inducement of lower rates, more insurance is not taken out under the state plan or other forms where "cheapness" is considered the chief attraction. There's a reason and in this case it is found in the fact that the state is either unable or unwilling to furnish the service which to business men is the all important consideration. Objections as a rule are lodged not against the rate but the quality of the goods, and competent service always has and will command an adequate price. These fundamentals are forgotten by our legislative visionaries whose theories seek to force the state into fields which it is not equipped to occupy. The history of adventures of this kind is an unbroken story of failure and the wonder is that there are still to be found men who are ready to trifle with our common sense in further experimentations. There is no one so well fitted to discharge a duty as he who makes a business of it. This is especially true of the complicated work of insurance and with its corps of experienced officials and trained agents, the stock company is best fitted to do the work.

Since compensation laws have been enacted, new methods have become necessary, and progressive companies like the Aetna, which I have the honor to represent, and others of its class, have led the way in insurance reforms. One of the many objections to the state insurance plan, where it is made compulsory and exclusive and which applied under former practice to insurance companies, is the charging of a flat rate or premium based on the pay roll of the insured. Under such a plan there is absolutely no inducement to prevent accidents as the net cost is the same whether the number of accidents in any given establishment be many or few. The justification of the liability company for this practice was that the verdict of juries under the common law procedure varied so much for the same kind of injuries that any other plan would be uncertain and difficult to enforce, but, with the enactment of laws limiting and specifying damages, it was possible to introduce a more scientific method, and that has been done by the Aetna company through what is known as the merit-rating system. In fixing an equitable premium rate, it is now no longer a guess but a matter of mathematical computation. This is determined by a study of the character of the institution, the experience of each individual plant, expert inspection service, and its actual accident record, thus furnishing the strongest possible inducement to the insured employer to accept the safety recommendations of the company's inspectors and by thus keeping the plant up to or above standard reduces not only the number of accidents, but also the insurance charges. This form of insurance is in every way commendable and the officials responsible for its introduction are entitled to great credit and deserving of our unqualified encouragement.

The part, I might say the important part, of the merit-rating plan is its superior service. The Aetna, the author of the method, employs a large force of competent inspectors who are selected solely on account of their ability and qualification for such work. I read a report of one of these inspectors relating to a single plant where the time required for inspection was 7 days. The report covered twenty-four typewritten pages and contained four hundred recommendations for improvements, and the inspector informed me that the disposition now among employers was to comply immediately with the inspector's recommendations. Inspectors employed by this company alone made last year more than one hundred thousand recommendations, all providing for increased safety in the operation of our industries. No one will contend that the state has the time or the force or is willing to vote the money necessary to conduct inspections of this character and no one should question the stupidity of legislation that would discourage or prohibit these life-saving agencies from carrying out the high purposes of the work in which they are engaged.

Recently the Archbald Coal Co., near Scranton, Pa., posted notices at their mine saying that any man would be discharged if he did not report for work the next day. Every man was on the job.

Washing Western Kentucky Coal

Results Obtained by the Use of Bumping Tables by the St. Bernard Mining Co., Earlington, Ky.

*By Newell G. Alford**

THE primary impulse which prompted the first washing of western Kentucky coals was the desire to manufacture a commercial coke from slack wasted at the mines, through the preparation of the coal for the market.

In the early period of western Kentucky's coal mining, its market called almost entirely for the larger sizes, hence the casting of the screenings into discard.

Mr. J. B. Atkinson, the late president of the St. Bernard Mining Co., was the man who first solved the problem of recovering western Kentucky's waste slack on a commercial scale, that would be at the same time practical and profit yielding.

Since the seams which yielded the output were classified as coking coals, Mr. Atkinson resolved to produce a coke which when crushed to small sizes—egg and chestnut—would find a domestic market as a substitute for the small anthracite sizes. As might be supposed, the waste slack passing through a ¾-inch screen contained the usual fireclay, slate, and sulphur; and thus the fact was developed that a washer must be adopted which would materially decrease the percentage of impurities in the resultant washed slack.

Thus, under the auspices of the St. Bernard Mining Co., western Kentucky coal washing was instituted at Earlington, in Hopkins County, as early as 1882, while the field was yet in its embryonic stage.

A trough, or sluice, washer was built 30 feet long, 2 feet wide, and 1 foot deep with an inclination of 1¼ inches to the foot. In connection with the sluice washer two beehive ovens* were constructed nearby that the research might include coking trials on the washed slack.

With this type of washer, difficulty was encountered in keeping the water feed and the coal delivery adapted to each other. Many small particles of coal contained (and still contain) thin sheets of pyrites, and these particles were floated with the clean coal, passing off with it to the washed slack storage. This process required the use of an excessive amount of water for its operation.

A jig washer was then installed to rewash the slack coming from the sluice. It was evident that this process was too slow, the jig refusing to clean the coal except when it was fed in small quantities from the sluice to the machinery. Even then notwithstanding the exercise of special care in operation the pulverized pyrites filtered through the mechanism and passed off with the clean coal, thus failing to accomplish the purpose intended.

Fig. 1. Washery of St. Bernard Coal Co., Earlington, Ky. Part of Abandoned Washery at the Left.

*Assistant Chief Engineer, St. Bernard Mining Co., Earlington, Ky.

*Mentioned on page 192 of Chief Inspector Norwood's Report of Kentucky Mines for 1895.

The best performance of this combination of washers sacrificed 4½ per cent. of the coal with the refuse, while the average operation discarded approximately 20 per cent. of the tonnage brought to the washery for treatment. The capacity of this preparing plant in 1889 was 100 tons per day, the coke oven installation at this time being on a commercial scale. The process used approximately 1,250 gallons of water per ton of raw slack.

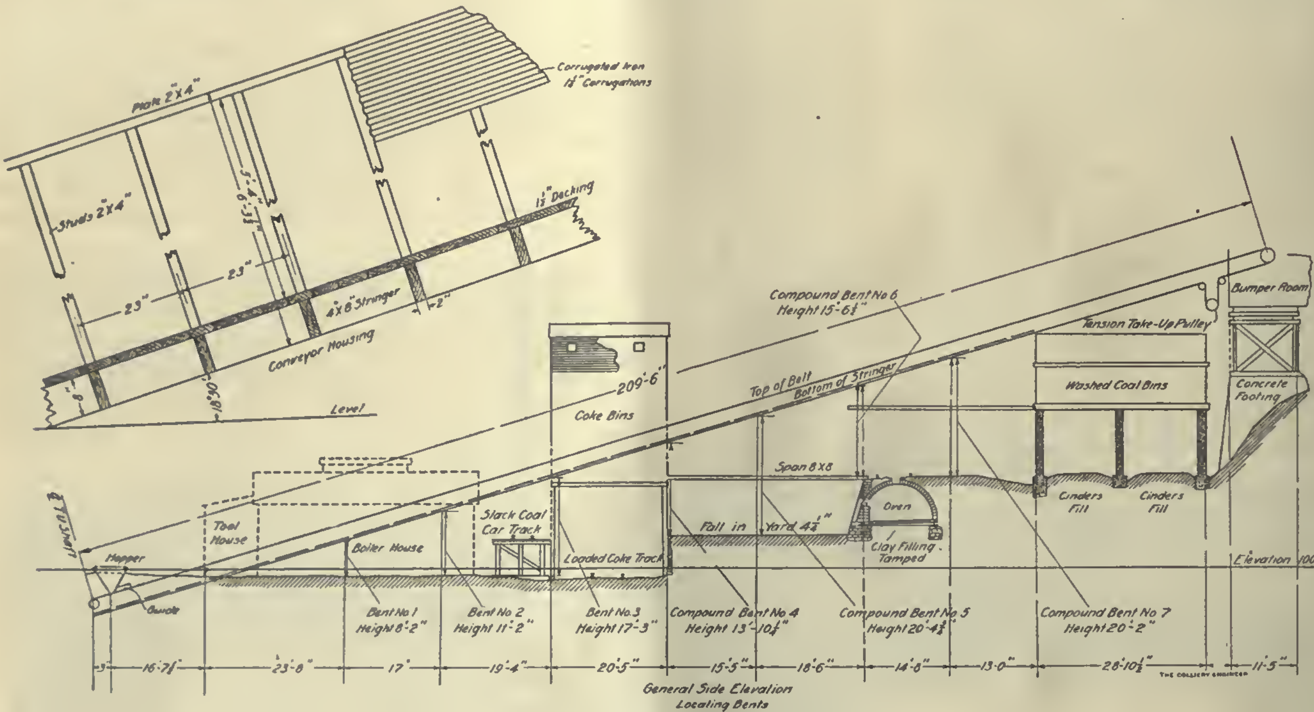


Fig. 2. Longitudinal Section Through Washery

Following this, slack from the No. 9 and No. 11 seams (it was Mr. Atkinson's purpose to utilize these in equal portions) was shipped to Birmingham and Pittsburg, where test washings were conducted in other types of jigs. Although the test washings on these machines removed a large percentage of impurities, they did not show a saving of coal commensurate with their dirt removing properties.

In the meantime, September, 1891, Prof. A. C. Campbell, of Nashville, Tenn., came to Earlington with a model of his ore concentrating table, a machine of the impact type. Arrangements were immediately made for testing out the properties of this machine, and it was found that the Campbell concentrator, or bumping table, would not only remove the well-defined pyrites, but the slime charged with fireclay and sulphur as well.

The surface of the table, which is 30 inches wide and 8 feet long, is supported by a keel extending from end to end. As shown in Fig. 3, a longitudinal section of the table, the bottom presents an irregular curve, which was developed by Professor Campbell, through experiment, as being of the most efficient curvature.

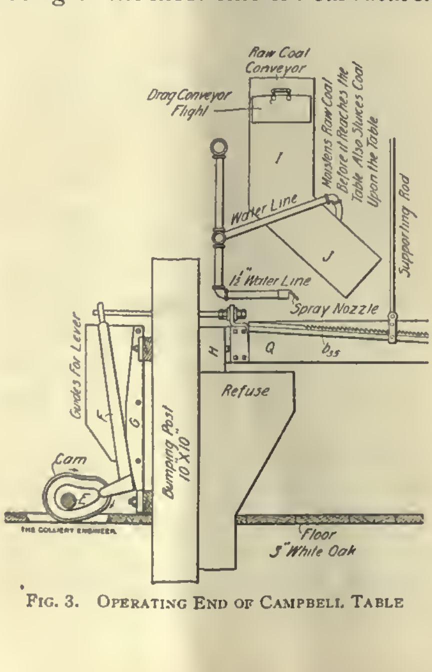


Fig. 3. Operating End of Campbell Table

The curved surface is then covered with galvanized sheet iron.

The bottom of the table, as just described, is overlayed with strips such as b_{35}, the cross-sections of which are trapezoidal. The saw-tooth surface thus constructed is next covered by narrow strips of No. 10 galvanized sheet iron, which project slightly beyond the edges of the wooden strips or riffle boards.

The sides of the table, the tops of which are parallel to the bottom of the keel, extend from the bottom upward and act as containers when the apparatus is in action. With the exception of the strips b_{35}, which are made of poplar, the table is constructed throughout of solid white oak.

When in operation, the cam-shaft E revolves clockwise, simultaneously revolving the cam, which through the action of the beam F on the rocker G, controls the direction of and transmits power to the table. A reciprocating motion is thus conveyed to the table.

The raw slack is fed upon the table through the hopper I which is below a scraper conveyer, running transversely above the battery of tables. The lower end of the hopper

is in the form of a chute, as *J*, from which the slack is sluiced upon the table by a 1½-inch water line. Water is also fed upon the table at the refuse end *Q* by a second 1½-inch water line through a spray nozzle.

The raw slack being deposited regularly upon the surface of the table, it is submerged in 4 inches of water or less, according to the variation in curvature of the bottom. By virtue of the relative specific gravities, the particles then seek their positions, the impurities sinking to the bottom, the clean coal rising to the upper stratum.

At the beginning and during the first part of the rotation, the cam, through the action of the beam on the rocker, generates a slow backward movement in the table toward the face of the bumping block *H*. As the end *Q* approaches the bumping block, the velocity of the table accelerates swiftly, being suddenly and momentarily brought to rest through impact with the block, thus ending the stroke. The continued rotation of the cam then brings a sharp reverse motion in the table, the speed being impeded in successive degrees until the completion of the reverse stroke, whence the cycle of movements begins anew.

The impact of the table with the bumper block diverts the heavier substances toward the rear of the table or refuse end, discharging the refuse at *Q*.

This action on the part of the denser substance is augmented by the saw-tooth character of the table bottom. When certain of these heavier particles, in the course of their progress toward the end of table *Q*, come to rest on the bottom of the table, through the momentary suspension of motion, they seek shelter under the galvanized strips. When the table is thrust away from the bumping block *H*, these strips prevent the backward movement of these particles along the bottom of the table whence they came. Thus this function of the strips, permits the refuse to move on the table bottom in but one direction. The reverse motion disburdens the table of the clean coal at the front end.


FIG. 4. SHOWING BOTTOM OF CAMPBELL TABLE


FIG. 5. TABLE AND FEED END

From their respective points of discharge from the table the coal associated with water and the refuse in similar mixture are conveyed by gravity in slightly sloping troughs to their particular bins.

It is estimated that one-fifth of the water supplied to the tables passes off with the refuse, while the remaining four-fifths flushes the washed coal into the storage bins. Here the water gradually drains off in perforated wooden boxes located vertically along the sides of the bins.

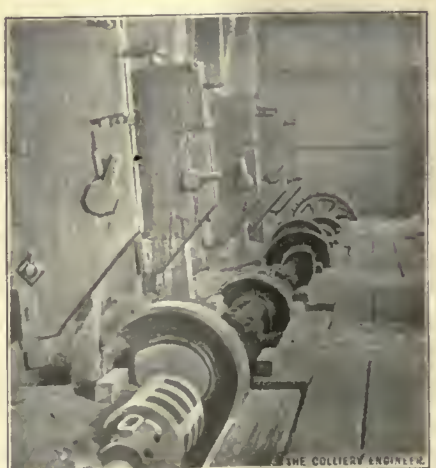


FIG. 6. CAM SHAFT FOR BATTERY OF TABLES

As is obvious, the larger portion of the water is released at the lower end of the table, with the washed coal, necessitating but a slight fall in the conveying troughs to the washed slack storage.

On the other hand, since the refuse, although extremely wet is possessed of distinctive adhesive properties and in addition to this is charged with much less water than the coal, a heavier inclination is therefore required to deposit the mixture in its temporary bin below the floor of the washery building.

From the temporary collecting bin the refuse is dumped, in quantities averaging 1¾ tons, into a wire-rope tram bucket. A single bucket, running on a 1½-inch cast-steel rope, propelled by a ⅝-inch diameter continuous cast-steel wire rope and a 60-horsepower link-motion engine, conveys the refuse from the washery to the summit of an ascent about 75 feet above the washery floor line. At this point an automatic tripper deposits the contents of the bucket in a hopper, which in turn empties the refuse into a mule-drawn dumping car. The refuse is then discarded on the gigantic waste heap.

From the recent investigation of the writer the determinations given in Table 1 are derived concerning the performance of the battery of five tables now in service at the Earlington plant.

The present installation, constructed under the supervision of the writer, was completed slightly over a year ago, at which time it superseded the previous plant constructed in 1898.

From the drop-bottom railroad cars, the slack passes through a hopper, below the track, upon a 20-inch belt conveyer furnished by the Link Belt Co. The carrying side of the belt, covered with a $\frac{1}{16}$-inch rubber cover, is supported by troughing rollers. This conveyer is 214 feet 6 inches, from center of foot pulley to center of head pulley, and when operating at a speed of 350 feet per minute on its vertical angle of 16 degrees 30 minutes, will elevate pea and slack coal at the rate of 100 tons per hour from the hopper to the washery. Twelve horsepower is required for this operation.

Fig. 7. Wire Rope Tramway for Conveying Coal

Fig. 8. Head-Frame and Refuse Hopper for Wire Rope Tramway

The belt is maintained taut by a tension take-up pulley, located immediately below the head-pulley and resting on the return belt. Rawhide lacing at the joint in the belt has proved very satisfactory. Infrequent renewal of lacing and refilling of oil cups is absolutely the only attention which this installation has demanded during its daily operation since June 1, 1913.

Upon its discharge from the upper end of the belt, the coal falls into a storage bin, from whence it is lifted by a bucket elevator and dumped upon the drag conveyer. The drag conveyer, as before stated, passes transversely above the battery of bumping tables and serves to supply them with raw coal. The washer room shafting and 20-inch belt conveyer are propelled by a 60-horsepower slide-valve engine.

Table 1. Comparative Analyses

Identification of Sample	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B. T. U. Dry	B. T. U. as Received
Equal portions of No. 9 and No. 11 raw slack coal..................	4.81	35.35	40.77	19.07	4.18	11,019	10,489
Above mixture washed....	15.80	32.84	42.39	8.97	2.82	12,755	10,739
Refuse..................	9.92	23.49	20.08	46.51	8.80	4.744	4.273

Note.—Specific gravity of refuse in this case was 2.03.

OPERATING DATA

Size of coal from tipple, passes ¾-inch screen.
Size of coal as washed, passes ¾-inch screen.
Speed of cam-shaft, 67 revolutions per minute.
Raw coal accepted per day, 900 tons.
Washed coal per day { Amount yielded by process, 756 tons. Per cent. of raw coal accepted, 84 per cent.
Refuse per day { Amount yielded by process, 144 tons. Per cent. of raw coal accepted, 16 per cent.
Percentage of good coal lost in refuse, 1.60.
Ash { Percentage of reduction, 52.90. Percentage removed, 60.51.
Sulphur { Percentage of reduction, 32.53. Percentage removed, 43.54.
Water consumption, 300 gallons per ton of raw coal.

The succeeding stage is that of washing, hereinbefore described.

The water supply for the process is pumped to a concrete reservoir, with a capacity of 46,750 gallons, from which there is a vertical fall of 37 feet to the roof line of the washery building. Approximately 300 gallons of water are required for the treatment of 1 ton of raw coal.

With but one exception, the St. Bernard Mining Co. is the only organization which has thus far attempted washing western Kentucky coal. In 1895, the Ohio Valley Coal and Mining Co., at De Koven, Ky., was operating a plant equipped with two Campbell bumping tables. This plant treated slack from the No. 9 seam only. Coal washing has since been abandoned at this operation.

Coal in Missouri

The occurrence of coal in Missouri appears to have been known as early as 1806, when according to "An account of expeditions to the sources of the Mississippi," etc., by Zebulon M. Pike, it was noted on the banks of the Ohio River. The coal attracted the attention of the early settlers and numerous small local mines are reported to have been opened by them. No record is extant of the quantity of coal produced in those early days in Missouri, and the first statement regarding the quantity mined in the state is contained in the report of the United States Census for 1840, in which year a production of 9,972 tons is recorded.

Exhaust Steam Turbines

The Utilization of Exhaust Steam—Economies That May Be Attained The Design of a Condensing Plant

By W. C. Mountain

The utilization of exhaust steam by turbines was first rendered practical by the Hon. Sir Charles Parsons, who found that by exhausting into a high vacuum he was enabled to obtain a considerable amount of power economically. The subject lay dormant for some time, until Prof. A. Rateau introduced his system for the utilization of exhaust steam in connection with the exhaust-steam turbine and his heat accumulator, which consisted of a large steam receiver containing water, or, as an alternative, iron rails or metal to absorb heat. By adopting an apparatus of this kind, where the supply of exhaust steam is intermittent, very satisfactory and economical results can be obtained.

Hoisting operations at a colliery are in many cases practically continuous and it becomes necessary, when utilizing exhaust steam from such a source, to provide for the periods when the engines may be stopped or when they are running intermittently. This condition is met by adopting what is known as the "mixed-pressure" type of turbine. Mixed-pressure turbines are also designed for working with any ordinary pressure on the high-pressure end, and also with superheated steam; but, as regards the low-pressure or exhaust-steam end, this is designed usually for a pressure of 16 pounds absolute—that is, slightly over 1 pound above atmospheric pressure. In specifications for a turbine of this kind, it is necessary to consider the most economical vacuum. For general purposes, some advocate a vacuum of 27½ inches of mercury with the barometer at 30 inches. Of course, with higher vacua a lower steam consumption can be obtained, but this requires a greater quantity of cooling water, and more power to drive the condensing machinery.

*Abstract of a paper read before the North of England Institute of Mining and Mechanical Engineers.

As an example of the consumption of steam required by mixed-pressure turbines per kilowatt. the following figures taken from specifications which the writer has received, show the consumptions which may be expected both upon high-pressure and low-pressure steam at full, three-quarters, and half load, and at varying vacua.

When working with dry saturated steam at a pressure of 70 pounds above that of the atmosphere, the consumption per kilowatt hour would be:

Loads	Vacuum		
	26 Inches	27 Inches	28 Inches
Full load	30.5	26.8	25.0
Three-quarters load	29.5	27.8	26.0
Half load	32.2	30.3	28.3

When working with exhaust steam at 16 pounds absolute pressure, the consumption of steam per kilowatt hour would be:

	Vacuum		
	26 Inches	27 Inches	28 Inches
Full load	39.3	35.5	31.7
Three-quarters load	41.0	37.1	33.1
Half load	44.2	40.0	35.7

It must, however, be remembered that in all installations where exhaust steam is used "dry saturated steam" is not obtained except by superheating the exhaust steam. The steam always contains some moisture, and, therefore, in making calculations as to the amount of exhaust steam required, the writer allows at least 15 per cent. upon the makers' guaranteed figures. In many cases for turbines of, say, 750 kilowatts, he has assumed an all-around figure of 40 pounds of exhaust steam per kilowatt at 16 pounds absolute pressure and with 27½ inches of vacuum.

The writer believes that for heavy hoisting, and where it is impossible to obtain electricity at low rates, the high-class modern engines exhausting into receivers from which the exhaust steam is utilized in mixed-pressure turbogenerators constitute an extremely economical system of working. In one of other papers by the writer is included information obtained relative to the consumption of steam per shaft horsepower, and the results varied considerably in accordance with the class of engine. By shaft horsepower is meant the actual horsepower required for hoisting, assuming that it is continuous. For instance, at a colliery hoisting 250 tons per hour from a depth of 1,800 feet, the shaft horsepower would be 250 tons per hour = say, 9,300 pounds per minute.

$$\text{Therefore } \frac{9{,}300 \text{ lb.} \times 1{,}800 \text{ ft.}}{33{,}000}$$

= 510 shaft horsepower. Such an engine of modern construction (not compound) would consume approximately 50 pounds of steam per shaft horsepower hour, assuming the steam pressure to be 150 pounds per square inch and superheated to 100° F. This consumption depends upon the construction and class of engine and also upon whether it has been correctly designed for its work; but the consumption of steam given is practically what has been guaranteed in some recent installations.

To show how great a variation exists, owing to the difference in kind of hoisting engine, and also to the steam pressure, the writer gives the figures of estimated steam consumptions per shaft horsepower compiled from the data contained in the paper cited. Notwithstanding the high consumptions in nearly all cases, the ultimate cost of hoisting by steam was considerably lower than the hoisting by electricity. For the ordinary run of the earlier hoisting engines it may safely be assumed that the consumption of steam per

shaft horsepower hour is about 100 pounds. As a rule, the figures may be obtained from the actual consumption of coal for the hoisting engines themselves. Assuming, therefore, the case of a mine equipped with two hoisting engines and utilizing, say 100 pounds of exhaust steam per shaft horsepower hour, it will be recognized that there is a very substantial asset in this steam, if properly used.

Assuming that each engine requires 25,000 pounds of steam per hour, and a fan engine consumes 10,000 pounds of steam per hour, or a total of 60,000 pounds of steam; then after deducting 15 per cent. for condensation losses, there will be available at least 50,000 pounds of steam. If this steam be used in an exhaust pressure turbogenerator, and assuming, so as to be on the safe side, that 40 pounds of steam are required per kilowatt at 16 pounds absolute pressure, 1,250 kilowatts will be obtained, which would be quite sufficient to drive the whole of the haulage, coal cutting, and possibly the pumping. This power would be obtained without putting any excessive back pressure on the hoisting engines or increasing the consumption.

The load factor must next be considered, and this, of course, has a great bearing upon the ultimate cost of producing the current per unit. In Table 1, therefore, are given the kilowatt outputs from a 500-, 750-, and 1,000-kilowatt plant, with load factors varying from 100 to 10 per cent.

Table 1. Kilowatts Produced at Varying Load Factors

Load Factor Per Cent.	500-Kilowatt Set Kilowatts	750-Kilowatt Set Kilowatts	1,000-Kilowatt Set Kilowatts
100	4,400,000	6,600,000	8,800,000
90	4,000,000	6,000,000	8,000,000
80	3,500,000	5,300,000	7,000,000
70	3,100,000	4,600,000	6,200,000
60	2,650,000	4,000,000	5,300,000
50	2,200,000	3,300,000	4,400,000
40	1,760,000	2,650,000	3,520,000
35	1,540,000	2,300,000	3,080,000
30	1,330,000	2,000,000	2,660,000
25	1,100,000	1,660,000	2,200,000
20	890,000	1,330,000	1.780,000
15	660,000	1,000,000	1,320,000
10	440,000	660,000	880,000

When there is heavy pumping at a colliery, and the fan is driven electrically, or where there is a considerable amount of endless-rope haulage, a much better load factor is, of course, obtained than at collieries where the power is used largely for coal cutting, main and tail-haulage, or work of that kind. But with a reasonably good load the load factor varies between 30 and 40 per cent., although in many cases it has fallen to 20 or 25 per cent., or even lower.

Occasionally, it is necessary to supplement the exhaust steam by passing a certain amount of live or high-pressure steam into the turbine, or even by running on high-pressure steam alone. In such circumstances, an addition to the running cost must be provided for the coal consumed and the stokers' and ashmen's wages, but this can be easily done, and the cost of the current generated readily calculated.

The foregoing figures (which are, of course, open to criticism but have been substantiated in practice) show how remarkably economical a mixed-pressure turbogenerating plant is when working under reasonably suitable conditions. In considering the design of a turbogenerator, one of the most important points is the clearance, both axially and radially, because when there is too fine a clearance, blade stripping is likely to occur.

Another matter of importance is to select a design in which there is not too great a length between the bearings. With a long shaft there is bound to be a certain amount of sag, and this is the reason why the present makers of the Parsons turbine have nearly always adopted the Curtis or impulse wheel for the high-pressure machine, in order to reduce the length. It is also essential that the combination of turbine and generator should be mounted upon a massive bedplate. It is imperative that the governor should be accurate, and of a type that will not only maintain constant speed under varying conditions of load, but will respond promptly to any sudden change of load, or change over from high pressure to low pressure, or vice versa, at practically a constant speed.

In considering the design of condensing plant, the class of water available for cooling purposes must be taken into account. The writer has found that at some mines the water is either dirty, or in such a state that it causes a deposit on the tubes of the surface condensers; and therefore, where it is not essential to have condensed water for boiler feeding, it is better to use the simple type of jet condenser. This is made in various types, including (1) the ejector condenser, in which no air pump is necessary; (2) the low-level jet, in which a dry air pump is necessary, as well as a circulating pump; (3) the Le Blanc condenser, in which a dry air pump and a circulating pump are required; and (4) the barometric condenser, which has much to recommend it, on account of its simplicity and the fact that when being used it is almost impossible to flood the turbine. With any injection condenser it is also necessary to provide efficient vacuum breakers to prevent risk of flooding.

In connection with turbogenerators which may be supplied, one or two points to note are the following:

1. The machine should be of ample size, so as to work without undue heating, and preferably one that will carry full load for 6 hours with a temperature rise in no part exceeding the temperature of the surrounding atmosphere by more than 70° F. The machine should be able to withstand an overload of 25 per cent. for 2 hours without undue heating, and a momentary overload of not less than 50 per cent.

2. The rotors must be well made, in order to secure accurate balance, preferably rotors made from solid forging, with slots in which to carry the conductors, secured by wedges of brass or suitable material, and with steel end covers. They should also be so designed as to admit of free ventilation and thorough cleaning, and the air ducts through the rotors and the stators should be kept clean.

Report on Coal-Dust Explosion Test

At the Experimental Mine of the Bureau of Mines, Bruceton, Pa., Before the Mine Inspectors' Institute of America, June 11, 1914

By George S. Rice and L. M. Jones

TEST No. 120 was made at the Bruceton experimental mine in the presence of members of the Mine Inspectors' Institute of America, from various parts of the United States and Canada, as well as some operators and miners. The most important purpose of the experiment was to determine the efficiency of various forms of rock-dust barriers in stopping the propagation of a dust explosion; another feature of interest was the employment of a strong ventilating current prior to and at the time the explosion was started. The main entry, Fig. 1, was the intake, and the air-course *A* the return. The loading of coal dust in the two entries was made as nearly alike as possible and since the igniting shot was fired in an offset at the middle of the inmost breakthrough, the conditions in the two entries were identical, except for the direction of the air-current. The zigzag line indicates the path of the flame.

Conditions of Test.—The explosion was caused by a blown-out shot of 4 pounds of FFF black powder, tamped with 3 pounds of clay, discharged from a cannon at the face of a 20-foot offset, on the north side of the 1,250 cut-through, equidistant from the two entries.

The offset and 1,250 cut-through were loaded with coal dust not mixed with other dust. The distance from the cannon through the cut-through to the center of either entry was about 50 feet.

From opposite the 1,250 cut-through, both entries were loaded on the side and cross-shelves with a mixture of 60 per cent. coal dust and 40 per cent. shale dust at a rate of 3⅓ pounds per foot. The amount of coal dust per foot of entryway was 2 pounds which is equivalent to about one-half ounce per cubic foot of entry space. This loading extended for 550 feet from the cut-through. The mixture had an ash percentage of about 38 to 40 per cent.

At the end of this zone on the entry there was installed a Rice concentrated barrier loaded with 2½ tons of rock dust. The principal features of the barrier are as follows:

It has two hinged platforms, 7 ft. x 7 ft. x 1 ft. deep, near the roof of the entry. The floor planks of the platforms are not attached to the

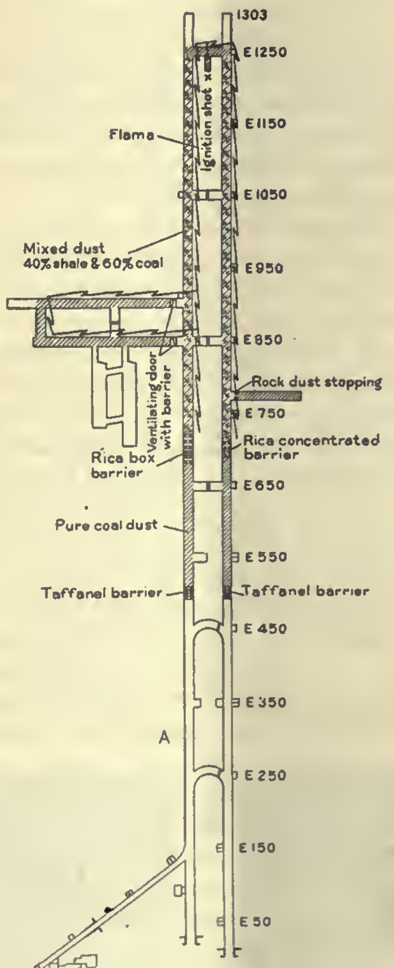


FIG. 1. PLAN OF EXPERIMENTAL MINE

side boards which are fastened to timber cross-bars but are hinged at one end to the cross-bar of a timber set, placed between the platforms. The other ends of the planks of each platform are supported by an angle iron, which in turn is held up by one of a system of levers. There are vanes hung from the roof 100 feet distant inby and outby the barrier, so arranged that when an explosion wave causes one to swing, the movement is reversed by a pulley and chain and a pull transmitted by wire to a trigger which trips a system of levers, causing the dropping of the angle irons supporting one end of each platform. Alternate planks then fall about 9 or 18 inches, as shown in Fig. 2, depending on the length of chains fastened to them and an overhead timber or to the roof, the side frame of each platform, however, being still held up in position. On release, the dust, which had been placed on the platform, falls from the planks in a shower in the entry blanketing the flame of the explosion when it reaches the barrier. Should the advance vane operating arrangement fail, another vane near the barrier, by means of a hinged bumping block attached to it, pushes the trigger, causing the operation of the barriers.

At the end of the mixed-dust zone on the air-course were installed a set of six Rice box barriers, spaced 10 feet center to center, each containing 600 to 700 pounds of crushed shale dust. These boxes are 7 feet long, 21 inches wide inside and 9 inches deep. The boxes are built so that two bottom boards rest upon narrow bottom strips fastened to the box frame. The box frame is supported by four eye bars, the eyes resting on hooks, projecting from the roof. When the explosion wave reaches the box, it causes the latter to swing in the direction the explosion wave is traveling until the side of the box knocks two hanging bars off the hooks, whereupon the frame falls, as shown in Fig. 3, pivoting about the supporting hooks on the other side of the box, to which the other two eye bars are still attached. The bottom boards do not fall with the box frame but drop a few inches when they are caught by supporting chains. More or less of the dust on

these shelves either falls off as they swing or is blown off by the explosion wave. With a light preliminary wave, considerable dust may remain on the shelves which is a measure of protection against a following explosion wave.

Outby both the concentrated barrier and the box barriers, were placed 200-foot zones of unmixed coal dust to furnish fuel for continued propagation of the explosion, should it get through the stopping devices, in other words to determine if the latter were efficient. At the end of these coal-dust zones were placed Taffanel barriers to check the explosion should the coal dust become ignited.

Across the mouth of the first right butt entry was built a rock-dust stopping which consisted of board sides with a compartment between them, 18 inches wide, filled with 2½ tons of shale dust. The sides were braced just sufficiently to withstand the pressure of the dust filling, but not enough to give much additional strength. Coal dust was placed for 100 feet inby the stopping to test its efficiency.

In the first and second left butt entries, 15 feet in from the air-course, were built rock-dust protected ventilating doors. These doors had compartments at each side and above them containing rock dust. The door frame held the boards of the compartments in place. When an explosion wave struck the door, the frame not being strongly braced would tend to become displaced and the rock dust would be launched into the entry. The door in No. 2 butt entry opened outward while that one in No. 1 opened inward. Unmixed coal dust was distributed in both entries to determine the efficiency of the stopping devices. To obtain symmetrical conditions in the air-course and entry, no door or curtain was placed across the air-course between the butts.

An air-current traveled with a velocity of about 850 feet per minute. It was thought that the symmetrical loading on entry and air-course would permit a good comparison of the effect of the high velocity air-current traveling with and against the explosion. This velocity gave a volume of 46,000 cubic feet per minute.

The mine was wet throughout. The bottom was muddy in places while the packed clay floor throughout was slightly sticky. The roof had beads of moisture on it.

Recording pressure manometers were placed in stations E-1150, 750, 550, A-1150, 750, and 550. Flame circuit-breakers were placed at all stations in the mixed-dust zone and others at intervals outby. Wires were connected to the stopping devices, terminating the mixed-dust zones, to determine the relation between the time of their operation and the passage of flame. Matches and guncotton tufts were installed every 25 feet throughout the mine to register the passage of flame.

Results of Explosion.—When the igniting shot was fired by the pressing of a button in the observatory, slight puffs of dust were noticed at the main entry and air-course accompanied by a very muffled report. Shortly afterward more dust came from entrances, particularly the air-course entrance and issued for some moments. Externally the explosion was very mild. When the ventilating current was turned on after a cloud of rock dust had been expelled, the afterdamp accompanied by an extensive cloud of black smoke attested that there had been a considerable explosion in the interior of the mine.

The flame of the explosion extended in the main entry and in the air-course to the respective rock-dust barriers, which were placed at points 550 feet from the outside of the mine or 700 feet from the origin in each case. The barriers in both cases operated and flame was not communicated to the pure coal-dust zones situated beyond or outby the barriers.

The ventilating door in the second butt, shown in Fig. 5, was evidently thrown down by the shock wave from the cannon as indicated by the elapsed time as recorded on the chronograph. When the flame reached it, about 4 seconds later, there had been sufficient time to permit the rock dust to settle, so that the flame passed over head and ignited the coal dust beyond, with the result that there was quite a strong inflammation at the head of the butt entries, sufficient to break the track and throw down shelving. This indicated that the door frame had not been put up sufficiently strong, since for the proper operation of the rock-dust device the frame should not have been thrown down until reached by the main explosion. This was the case with the first left butt ventilating door probably because this door opened inward. The barrier surrounding this first left butt door was thrown down apparently by the main explosion although it is not perfectly clear from the time records whether it may not have been thrown down by the explosion which came around from the second butt. In either case there was apparently sufficient rock dust launched into the air to quench the strong explosion coming out of the butts.

The pressures as recorded by the different manometers showed that the explosion was a very light one, partly due to the dust being mixed, and perhaps also due to the very wet condition of the mine. The maximum pressures at E-1150 was 2.4 pounds; at E-750, 5 pounds; and at E-550, zero. The pressures at E-750 and 550 show the effect of the concentrated barrier in extinguishing the flame. In the air-course the pressure at A-1150 was 1.4 pounds and A-750, 1 pound. This latter pressure in view of the considerable development of force at the head of the butt entries is rather surprising, and indicates the ventilating door barriers in the butt entries if they did not stop the explosion on entering, did so on the return wave. At A-550, outby the box barrier the pressure was zero.

The velocity of the explosion was one of the slowest that has been recorded. It required 3.2 seconds to traverse a distance from the origin

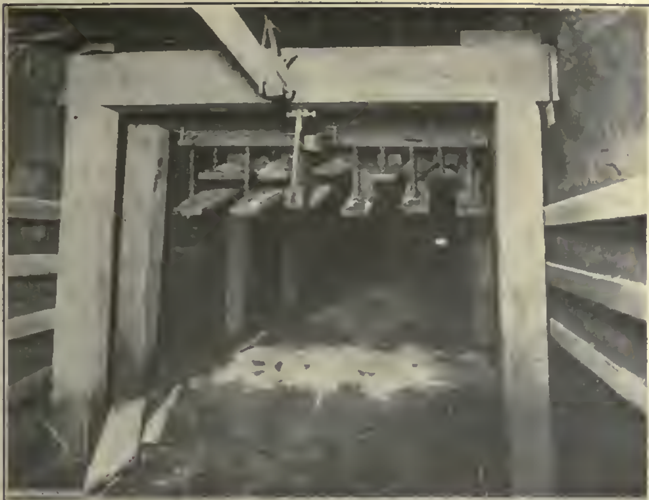


Fig. 2. Rice Concentrated Rock Dust Barrier After Explosion

Fig. 3. Rice Box Barrier After Explosion

to the station at E-1150 in the entry, a distance of 150 feet, and 2.9 seconds to station A-1150 in the air-course, also 150 feet from the origin. The explosion required 6.5 seconds to reach station 750 in the entry and 5.1 seconds to reach the corresponding station in the air-course. The average velocity of flame between stations on the return air-course, 182 feet per second, was greater than the average velocity of flame between stations on the intake entry, 131 feet per second.

It would not appear from the pressure and velocity records that the high velocity of the air-current had much influence on the development of the explosion. About the only variation in the development of the explosion in the two entries was that the velocity of flame on the return side was somewhat greater than that on the intake side. While this may have been an effect of the ventilating conditions, it was probably more a matter of chance than from any effect of the air-current, since the explosion was such a slow one.

As the explosion was very light the concentrated barrier in the entry was not broken up or injured. The shelves had dropped until the supporting chains were taut and about 80 per cent. of the dust had fallen from them, the remaining 20 per cent. being still retained on the planks. The barrier operated 5.44 seconds after the shot was fired while the flame reached it about 7 seconds after the shot; the rock dust that sifted down apparently made a sufficient dust curtain to extinguish the flame.

The box frames of the box barriers were found lying on the floor of the entry, only one being damaged to any great extent. The bottom boards were all suspended from the chains and only one had been broken. All of the dust had fallen from the boards which were supported in a tilting position. The boxes operated at period 4.9 seconds, while the flame reached the boxes about period 5.5. The rock dust showed good distribution along the air-course.

The record indicated that the rock-dust stopping shown in Fig. 4 had been blown down, at least partially, when struck by the shock wave from the igniting shot at a period .473 after the shot. The stopping was probably built unnecessarily light. It had operated effectively since flame did not penetrate inby the stopping.

The rock dust protected door in

Fig. 4. Rock Dust Stopping After Explosion

Fig. 5. Ventilating Door with Rock Dust Barrier After Explosion

No. 2 butt had been thrown down by the shock wave at period .429, while flame reached this point it is estimated after a period of about 4 seconds. The dust compartment of No. 1 left door fell, according to the time of rupture of the wires, after a period of 4.9 seconds, the flame reaching this point possibly a little before.

It is probable that the flame passed into No. 2 butt over the dust pile which had fallen possibly enough in advance so that much of the dust in the air had settled. The flame may or may not have passed through No. 1 butt barrier.

The woodwork of both doors had been broken to fragments by the return wave from the butts and the fragments thrown out to the air-course and both outby and a short distance inby on it.

The failure of No. 2 butt door is undoubtedly due to the frame being braced too lightly. It should not have gone out with the shock wave. Also it would be better to hang some of the boards from the roof by chains as in the case of the box barriers in order that some of the dust might be retained for delayed flame.

All but one shelf of the Taffanel barrier in the main entry was thrown down by the explosion. All shelves of the Taffanel barrier in the air-course were still up and about two-thirds of the rock dust was still on the shelves. Owing to the concentrated barrier and the box barrier having stopped the flame the Taffanel barriers were not brought into action.

Conclusions.—The results are valuable as showing the effectiveness of the concentrated barrier and the box barrier in a weak explosion. Their method of operation permits a surer and more effective scattering of the dust than does the open shelf type of barrier in which the amount of dust blown off the shelves depends upon the strength of the air-current. In a weak explosion, the amount blown off might be too small to effectively quench the flame.

Handling Coal at Panama Canal

Arrangements Provided for Unloading from Ships, Storing, and Loading Into Other Ships

By J. F. Springer

THERE will be a number of reasons for the maintenance of large coaling facilities in connection with the Panama Canal. In the first place, the operating machinery of the canal itself will require a large supply of coal readily accessible. Then coal must be kept in storage ready for naval use. In addition a large quantity will have to be kept on hand for emergencies. These are governmental requirements. It is estimated that the storage facilities necessary to meet these needs will call for a total capacity of half a million tons. If we add the storage which will be needed to take care of the requirements of private persons and companies, the grand total capacity will probably amount to 1,000,000 tons.

Two plants are to be provided, one at either end of the canal. These will not be of equal capacity. That at the Atlantic terminus will be much the larger. The explanation of this is probably found in the fact that the bulk of the coal will doubtless be shipped from Atlantic and Gulf ports. And coal ships going through the canal would have a round-trip toll charge that would enhance the price considerably. So it is likely that it will be Atlantic coal that will be stored on the Atlantic side and Pacific coal on the Pacific side.

The great coal plant at Cristobal with its enormous capacity will maintain a gigantic storage pile 1,700 or 2,000 feet long and 250 or 300 feet wide, having a height —throughout at least part of its area—of 40 feet. The low half will be under water. The wet coal will be largely that reserved for the navy. The top of the dry part of the pile will be about 21 feet above mean sea level. However, the emergency dry pile will have a summit elevation 10 feet higher.

The mechanical apparatus will consist of four unloading towers, a number of stocking and reclaiming bridges, several reloaders, a conveying system, and various other items. It will cost about $1,300,000 and be completed some time in 1915.

There will be two water fronts to the storage pile. At the one wharf coal vessels will be discharged; at the other, vessels of all descriptions will take on coal. The government will be prepared to store separately for different individuals and companies. When coal is taken off from vessels, it may be put into the storage pile at any point desired, or transferred to the conveying system or to cars. By means of the conveying system and reloaders, coal may be quickly transshipped from a vessel alongside the one wharf to another vessel alongside the other wharf.

The unloading towers are a notable part of the equipment. Each is a tall steel structure broad at the bottom and tapering almost to a point at the top. At the bottom, the tower rests on four four-wheeled trucks which run on two parallel narrow-gauge tracks. Within the tower is propelling mechanism by means of which the entire structure may be moved forward or backward on its duplex track. The track parallels the edge of the wharf, so that the unloading tower may vary its position relatively to the vessel alongside. Suspended from the peak of the skeleton structure of the tower by means of a system of supporting ropes is a long horizontal bridge on which is arranged a track for the movement back and forth along the length of the bridge of a carriage which supports a large grab bucket. This bridge extends through the open body of the tower, overhanging the vessel at the wharf on the one side and reaching the

storage pile on the other. On the shore side between the tower and the storage pile is a trestle work supporting a double track; so that the inshore reach of the bridge is very considerable. Beneath the bridge and constructed as part of the tower is a hopper having a capacity of 50 tons of coal. It will be understood from what has already been set forth that coal may be taken by the grab bucket either from the vessel being unloaded or from the stock pile and deposited into this hopper. The hopper is constructed of ⅜-inch steel plates. It delivers through a chute to railway cars standing on a track which is straddled by the lower part of the tower; or else to the conveying system operating on the trestle work already mentioned which is located between the tower and storage pile. There is an apron on the water side of the tower which facilitates delivery through the hatchways of vessels. This may be folded up against the side where it is out of the way. The grab bucket has a capacity of 100 cubic feet. The hopper is 12 feet wide and 30 feet long. This hopper performs the function of a reservoir in that it acts as a place of temporary storage for coal coming ashore or going to ships. It is not absolutely correct to call the tower and its equipment an unloader. It accomplishes more than that, as it will be used to load as well as unload vessels.

The stocking and reclaiming bridges are the usual long trusses moving broadside on, backward and forward, on two widely separated tracks. Each unit will have two grab buckets of 200 cubic feet capacity. These are operated to and fro lengthwise of the bridge and may, if desired, perform at the same time their hoisting movements. These bridges will be movable along their tracks at 50 feet per minute. They are self-contained and self-propelled, electricity being the motive power employed, and they are mounted on eight four-wheeled trucks. The bridge buckets will be able to reach coal in any horizontal and vertical position or to deposit coal at any location. The bridges are served by and deliver to the conveying system. Their individual capacity is rated at 1,000 tons per hour.

The reloaders have the duty of receiving coal from the conveying system and then making delivery of it to vessels. As the latter will vary a good deal in respect to size and the location of hatches, it is necessary that the reloading arrangements shall be flexible. Consequently, the unloader is provided with a hopper which receives coal from the general conveying system, and an individual conveying system by means of which coal is taken from the hopper to the discharge end of the reloader, where an adjustable boom controls a telescopic chute. By means of these arrangements, the unloader is able to take care of big ships and others not so big, and to deal with their individual peculiarities. The reloaders operate on the reloading wharf, where they may be moved back and forth on rails provided for them. These machines have a rated capacity of 500 tons per hour.

The general conveying system provides for the local transportation of coal to and from various points within the plant. It connects different parts of the storage pile and puts the pile in connection with unloaders and reloaders. Further, the conveying system puts the wharf bunkers into touch with the storage pile and the unloaders, and it is said that it permits two vessels to unload coal destined for the same part of the storage pile at the same time.

Cableways To Be Used for Handling Coal at Panama Canal

On the loading wharf a steel-and-concrete bunker will be constructed having a capacity of 1,500 tons. There are three compartments of equal size, each provided with two valves. The delivery openings which may thus be brought into service have a cross-sectional area of 6 square feet. The floors of the individual bins are tilted at an angle of 45 degrees, which is sufficient to provide a good rate of flow. The openings through which coal is delivered from the bins are 28 feet above the wharf. By means of a folding chute, delivery may be made at a level 7 feet below it. This is the lowest delivery point of the chute. Its highest is 14 feet higher up. In addition to these arrangements, each bin has a second chute which delivers coal at a constant level of 5 feet above the wharf. The wharf bunker provides for the coaling of barges, tugs, and such vessels.

At Balboa, on the Pacific side, the coal plant will be not so large as

its companion. There will be unloading towers and other apparatus similar to that which is to be installed at the larger plant. But instead of employing specially designed and constructed bridges for the purpose of reclaiming coal and stockings it, the cableways which have been employed at Miraflores in concrete construction, will be modified and brought into service. As these originally cost about $300,000, the incentive to their utilization will be readily understood.

Coal handling plants no doubt fall into several general classes in each of which certain elements or features are more or less fixed. And yet, on the other hand, nearly all situations, or at least very many, call for special arrangements to meet the special conditions. Panama has been no exception. Here the perhaps not unusual requirement that the several units be mutually independent has been transcended. What had to be taken into account was not merely the vicissitudes to which an ordinary commercial plant might be expected to be subject, but in addition the eventualities of war. Cristobal and Balboa are going to be great naval coaling stations. It is proposed not simply to have coal on hand in storage, come what may; but to have a loading and unloading plant which should be on hand ready to perform its duties. So, for one thing, the towers are not to be operated by electricity from a central station. Such an arrangement would result, in the event of a hostile capture of the station, in putting the handling plant entirely out of commission.

The six towers therefore are to be operated by steam. Each will be a self-contained unit in respect to power. The engines, located in the large quadrangular space in the tower just below the big hopper, will get their steam from a boiler equipment situated in this same space.

There will always be coal. So ir, at Balboa for example, three towers should be demolished or captured, there would still be a fourth unit capable of operation. Further, the towers are independent of the conveying system. If the latter is, for any reason, out of commission, the towers are competent, without its assistance, to load vessels from the storage pile and to unload vessels and deposit the coal on the pile. Indeed, coal may be transferred from one vessel to another by means of the tower alone. The outboard portion of the boom has a reach of 61 feet, so that a coal barge and a ship may be abreast close up to the wharf—in this way making it possible to reach hatchways in both.

The towers are structures of considerable size, as may be gathered from some of their dimensions. All six will have a height of 150 feet above the rails, which means the elevation above the concrete floor, as the rails will be sunk so as to have their heads flush with the general surface. The inboard reach of the boom from the framework of the tower will be 71 feet. The outboard reach, as already said, will be 61 feet. The boom will be 79 feet above the rails. The four-wheeled trucks which support the entire load will run on two tracks, either of which will have a gauge (center to center) of 3 feet. From truck track to truck track, center to center, will be 34½ feet.

Two of the trucks, one on either track, will drive, while the others will trail. The transmission will be by worm gearing.

Altogether, there are to be four different power units to each tower. The main engine is the hoisting unit, a double-cylinder 18″ × 24″ machine. This engine is direct connected. The engine which effects the traversing movement of the trolley is of 12 in. × 14 in. size, and is also of the double-cylinder reversing variety.

A third engine, 10″ × 12″ geared unit, performs the duty when necessary of raising and lowering the boom and of effecting the propulsion of the driving trucks. A 6″ × 8″ double-cylinder engine operates the 42-inch conveying belt.

Mineral Resources of the United States

It is announced by the United States Geological Survey, in order that the results of the Geological Survey's work may be given promptly to the interested public, the annual report on the Mineral Resources of the United States will be published in chapters, each chapter to be issued as soon as the statistics for it have been published. The following chapters have been published for 1913:

Bauxite and aluminum; manganese; gold, silver, copper, and lead in South Dakota and Wyoming; chromic iron ore; recovery of secondary metals; mica; fuel briquetting; sand-lime brick; sulphur, pyrite, and sulphuric acid; mineral paints; slate; potash salt; Fuller's earth; cement; feldspar; talc and soapstone; barytes; silica; abrasives; phosphate rock; sand and gravel.

On the completion of the volumes title pages, tables of contents, and indexes will be issued and will be furnished to those who wish to assemble and bind the chapters.

Librarians and others should preserve these chapters as they will not be supplied again in the form of complete volumes.

Earliest Coal Mining in Indiana

Some knowledge of the coal resources of Indiana was obtained as early as 1804, when the public-land surveys showed a number of outcrops. The report of the Geological Survey of Indiana published in 1872 states that in 1811 coal was dug at Fulton, in Perry County, and taken by Robert Fulton aboard the steamer Orleans on its first trip down Ohio River. There is good reason to believe that coal continued to be mined for local consumption between 1811 and 1837, when the first attempt at commercial mining was made, but there is no record of the quantity mined during that interval. The first commercial coal

mining in Indiana, according to E. W. Parker, of the United States Geological Survey, was done by the American Cannel Coal Co., at Cannelton, Perry County, in 1837. The coal was mined on the bluffs along the Ohio and Wabash rivers and for the first 10 years of the company's operations was loaded directly into boats for shipment to points down the Ohio.

In 1840, the United States Census reported that the production of coal in Indiana in that year was 9,682 tons. The industry developed slowly until 1865, when it was ascertained that the block coal mined in the Brazil and Terre Haute districts made a satisfactory blast-furnace fuel in its raw condition. At about that time the construction of railroads through the state gave an impetus to the coal mining industry, which has shown steady progress except when affected by periods of depression and labor disaffections.

The record for production was made in 1910, when it was 18,389,815 tons; the production for 1913 was 17,165,671 tons.

The West Virginia oil output in 1913 was valued at nearly $29,000,000. While no pool was developed during the year, drilling was more active than ever.

The Superior Coal Co.

Enormous Daily Productions in Southern Illinois—The Organization That Turns Out the Coal

By William Z. Price

NEAR Gillespie, Ill., on the Chicago & Northwestern Railway, are located the three mines of the Superior Coal Co., a subsidiary of that railroad. The mines, Nos. 1, 2, and 3, are similar in nearly every particular and began operation in the order named.

Fig. 1. Surface Plant, No. 3 Mine, Superior Coal Co.

The method of mining is with a two-entry system and by room and pillar. Rooms are driven 30 feet wide on 50-foot centers, entries are driven 21 feet wide on 60-foot centers for main and haulage roads and 50 feet apart on the butt entries. The seam mined is No. 6 and averages 7½ feet in thickness. No. 1 mine employs 600 men, No. 2 and No. 3 each employ 675. No. 1 mine has 90 entries being driven and 230 rooms, No. 2 has 88 entries and 250 rooms, No. 3 has 86 entries and 250 rooms and they have produced 4,530 tons, 5,133 tons, and 5,116 tons a day, respectively.

The coal is mined out by shortwall, breast, and punching machines, 107 in all, of Jeffrey, Ingersoll-Rand, Sullivan, and Harrison types. Jeffrey and Goodman electric locomotives are used for haulage.

Near each shaft bottom is located a switchboard with four switches, one for the machines, and one for the locomotives, on each side of the shaft. The feed-wire for the machines is on the main roads with a separate switch for each entry.

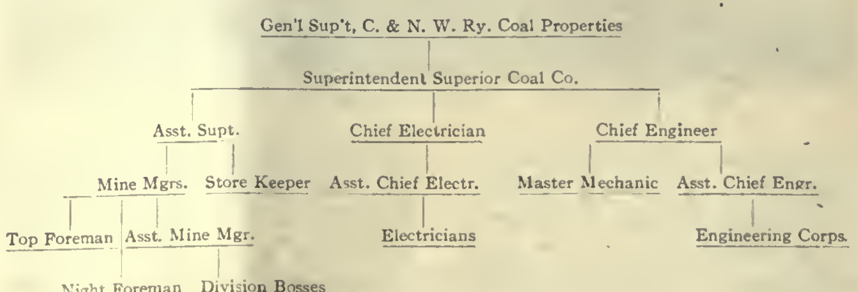


Diagram of Organization

The production of these mines ranks them as the largest in Illinois and when it is considered that the plants were designed for but 3,000 tons capacity, the natural inference is that an admirable organization

Fig. 2. No. 2 Power House and Tipple, Superior Coal Co.

Fig. 3. Surface Plant, No. 2 Mine, Superior Coal Co.

must be in control. This is shown by the diagram of organization. This feature is strongly in evidence, and the shaft is never kept idle waiting for the coal, and when it arrives at the foot of the shaft it is hoisted with amazing rapidity. At the time the record of 5,133 tons was made at No. 2 mine, the hoisting engine lost but 9 minutes in motion in the entire 8 hours. They use the Herzler & Henninger automatic caging device. Through an arrangement of the levers at the shaft bottom, as shown in Fig. 5,

Fig. 4. Washery, Superior Coal Co. Largest in United States

the automatic caging of the cars is accomplished. The empty car being released from the cage is forced off by the loaded car and the catch which has been tripped to release the empty is then free to engage the loaded car. The cage is self-dumping and the tilting platform is provided with an automatic lock. When the wings holding the loaded car on the track near the foot of the shaft are released, those in the rear spring up and engage the car following. When the cage starts up the shaft the rear wings are released and the car moves forward until it is caught by the wings next to the shaft. The empty cars are also handled automatically. They run by gravity to the base of a steam car lift where they trip a lever which acts as a throttle and the rails, which are hinged at the top of the incline, raise until the car runs off by gravity. As it leaves the lift it trips another lever which shuts off the steam and the rails return to their original position. The cars then run on to a kickback and are shunted to the right or left according to the demand.

The shafts at the three mines are 346, 320, and 384 feet deep, respectively. The coal drops from the cages into 5-ton steel hoppers suspended from the scale beams where it is weighed. The hoppers have a steam gate at the bottom which is operated from the scale house. Through this gate the coal runs on to a ½-inch bar screen. No further sizing is made. The slack coal goes to the washer.

The latter was built by the American Washer Co. and is the largest washer in the United States. It has eight jigs of the Stewart type. The screenings are unloaded by a combination spiral drag and bucket-elevator system into bins over the jigs. The coal is washed, elevated into reloading bins and loaded at the opposite end of the building. The washer has a capacity of 2,500 tons a day but has produced 1,400 tons with only one side in operation.

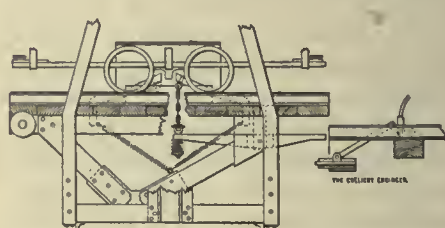


Fig. 5

The refuse removed amounts to from 6 to 8 per cent. of the total volume.

Each mine is equipped with a power plant consisting of two 200-kilowatt Westinghouse direct-current generators, direct connected to single engines; and also a Litch-

field duplex hoisting engine with a double conical drum, 7 and 8 feet diameters. A machine shop at No. 3 mine acts as a clearing house for repair work from all the operations.

The Chicago and Northwestern Railway takes all the coal produced and also the ashes from the boiler houses. Fairmont car retarders are used to facilitate the loading of the coal on the railroad cars.

The company is among those foremost in the state in welfare work. In case of a severe accident at the mines, a reminder of the same is printed on the due bills the following pay day and the men are thus cautioned against a repetition of the accident.

Next to Godliness

Written for The Colliery Engineer by R. T. Strohm

Up from the cavernous depths to the light,
Up from the region of shadows and murk,
Out of the chambers where day is as night,
Trudges the mine worker fresh from his work.
Grimy and stained are the garments he wears;
Coal dust besmirches his features with jet;
Thus through the streets of the city he fares,
Reeking with odors and clammy with sweat.

Ladies and lassies, all dainty and sweet,
Shrink from his path as he passes them by;
Even the men that he chances to meet,
Fling him a withering glance of the eye.
Homeward he plods in his rags and his dirt,
Slighted by mortals no better than he,
Nursing in secret his wrath and his hurt,
Less of a man than God meant him to be.

You for whose wealth he is risking his life,
Treat him as more than a digging machine;
Let him go home to his kids and his wife,
Bodily, mentally, morally clean.
Give him the means for a bath, to renew
Vigor destroyed by the shovel and pick;
Then all the liquors that helldom can brew
Cannot induce him to sample their kick.

How can he walk with a confident stride,
Dressed in apparel befitting a tramp?
How can he foster a spirit of pride,
Squalid and smutty and sodden with damp?
If you would check his career to the dogs,
Fill him with energy, courage, and hope,
Give him a building for changing his togs,
Furnish him plenty of water and soap.

Explosion at the Lothringen Colliery, Westphalia

The explosion which occurred in the morning shift of August 8, 1912, at I and II pits of the Lothringen colliery in the Northern Bocum district, was the most serious disaster that had befallen the German mining industry since the Radbod catastrophe of the autumn of 1908. No less than 107 persons were killed outright, and of the 23 injured survivors, seven subsequently succumbed.

The four seams worked here were worked through four haulage shafts and four separate levels; they lie in a fairly flat syncline belonging to the bituminous coal group, and are covered by an average thickness of 525 feet of marl. The evolution of pit gas in the northwestern district of the colliery is especially marked, and yet it hardy ever has attained the percentage in a split air-current of 1 per cent. methane. Still, whenever new workings were started, a notable evolution of gas (chiefly in the form of blowers) was recorded, and on this account shifts were often suspended for weeks on end; but, concurrently with the establishment of airways and the progress of forewinning, the evolution of gas gradually diminished. The coal seams are not especially dusty; nevertheless, spraying is regularly carried on in accordance with the Mining Bureau's ordinances.

Two explosions had previously occurred at the colliery, but not much damage had been done by them. In the course followed by the explosion it is noted that the deposition of "coke" was not very extensive; whence it is inferred that coal dust can hardly have played a predominant part in the initiation and propagation of the explosion.

There appears to be no doubt that unauthorized shot firing with dynamite had taken place in a cross-cut, which had not been reported as free from gas. As a consequence of this disaster, the regulations in regard to shot firing have been made still more stringent than heretofore. The circumstances connected with the mine and the conditions found after the explosion are quite similar to those at Eccles, W. Va., explosion.

Under conditions more difficult, the coal miners of West Virginia have excavated 542,949,446 cubic yards of coal, while the Panama toilers in open air excavated 295,323,000 cubic yards of material.

Mine Telephoning Without Wires

By J. L. Springer

Germany has produced a remarkable system of telephony which is especially adapted for use in coal and metal mines. No wires are employed. On the other hand, it is not a wireless system in the ordinary acceptation of that term. Electric currents are carried by conductors, which are the rails and pipes already placed in the mine for far different duties.

TELEPHONE IN OFFICE

In telegraphing and telephoning whether by means of wire conductors or by means of electric "waves," there is a fundamental fact which it will be well to have clearly before us. The message is transmitted by first creating fluctuations in electric activity under control of a person at the sending station, and by producing in the second place a precisely similar series of electric fluctuations at the receiving station. In the case of ordinary wire telegraphy, the current in a closed circuit is mechanically interrupted at the sending station and produces the same interruptions at the receiving point. The latter interruptions are translated into mechanical movements and these into clicks by means of making and destroying magnets. In telephony, the matter is somewhat similar, only there the voice sets up vibrations in a diaphragm which through the current in the closed circuit create similar vibrations of the diaphragm in the receiver at the other end. Marconi wireless and other systems use a stream of electric waves instead of an ordinary current. No conductor is necessary for this. We may deal with this stream similarly to the way we deal with the current in ordinary telegraphy and telephony and thus produce wireless telegraphy and wireless telephony. It will be gathered from the foregoing that fundamentally wire transmission and wireless are very similar. What we need is a current or a stream of electric activity connecting the two stations.

So it is with the new system. It utilizes a current which it has been found possible to create underground, but apparently not on the surface. There is a transformer at the sending point which converts the ordinary current employed into one having a high pressure. It is then possible to send the high-pressure current through the system of rails or pipes in the mine. It is here where the difference between underground distribution of electric charges from surface distribution is taken advantage of by the inventor, Herr Reineke. It is said that under no conditions will a spark be produced, and that other currents in the neighborhood neither affect nor are affected by this telephone current. These nearby currents may be direct or alternating; they may be heavy power currents or weak signaling currents; it makes no difference. Nor do the ordinary wireless waves interfere with it.

The telephone instruments are very similar insofar as outward appearance goes; but the transformer is an added feature. Anywhere along the conducting system a telephone may be installed either permanently or temporarily. A bell is used to call attention. This is arranged with a special relay, which may be especially tuned to respond only to its individual signal. Otherwise, when the button is pressed at a transmitting point, the bells of all the receiving stations will ring. For the message to be received, it is only necessary to take the receiver off the hook, just as with ordinary instruments. All stations may be spoken at once by using a suitable signal to call universal attention. This is an important matter in the mines, as it enables a warning to be sent everywhere at once. The current necessary to operate this system may be furnished by an ordinary battery.

The instruments are both fixed and portable. One type of portable apparatus only weighs about 20 pounds. Set up temporarily at any point convenient to the rail or pipe systems, it can be used to call up any station or ordinary instrument then on the line. Likewise, it may be called up by any instrument. A still smaller affair can be used in pretty much the same way, except that it cannot be called. This is a pocket instrument and is of a size that may be readily carried out by persons connected with the management. If the mine is a pit, a fixed instrument may be installed on the surface and connected with the

TELEPHONE ON CAGE

hoisting cable or with the piping system. Arrangements may be made permitting this telephone to communicate with the underground

telephone in general; but it is said to be more convenient for its messages to be repeated from a telephone set up at the bottom of the shaft. In a metal mine arrangements may be made to connect the various levels. The ore bodies do not interfere with operation. By the use of certain accessories, communication may be arranged for between the man operating the hoisting engine and the cage in the shaft. He can throw the telephone in or out by a slight movement which does not require him to take his hands off the levers. Further, it is possible to arrange in a simple manner for communication between the cage and the bottom of the saft.

This system of telephony has been in use for 2 years or more in the coal mine Carolinenglück Hütte in the Westphalian district in Prussia, Germany.

Safety First

The Susquehanna Coal Co. started a safety-first movement among its employes in June, 1913, and at the end of 12 months the results were remarkably encouraging to the officers of the company. Among other means to forward the movement, Manager Robert A. Quin had printed, July 1, small books of "Instructions and Safety Regulations for the Guidance and Protection of Employes." Every employe who receives this book acknowledges its receipt through a numbered return blank corresponding to the number of the book, and it is requested that he take it home and study the "Don'ts" it contains.

Among the interesting features connected with this movement was the appointment of safety inspectors, whose duty it is to travel through and inspect certain portions of the mine with the object of ascertaining anything that may lead to an accident and have it corrected. The chief duty of the inspector, however, is to teach carefulness to miners and to educate them to care for themselves.

The safety inspectors are under the jurisdiction of the mine foremen to whom they report. The following abstract from the book of "Don'ts" defines the duties of an inspector, which are sufficiently numerous to keep him employed.

He is to make daily reports stating the places inspected and what has been done to secure the safety of the employes. He is to test for gas every time he enters a working face, and also test the roof, ribs, and face.

Every condition that may lead to an accident he is to report to the foreman, and also note when the conditions are remedied.

If on examination he finds timbering in a dangerous condition he is to instruct miners to set timber without delay, and see that orders are complied with, then report to the foreman or assistant foreman immediately. He is to travel along roadways and examine the roof and the timbers, and report at once any dangerous conditions that need correcting for sure safety. Among other duties he is to examine all safety devices at the top of shafts and slopes and report at once to the foreman or his assistant if repairs are needed.

He is also to report all abandoned workings and entrances to dangerous places that should be fenced off and the sign "Danger, Keep Out" placed thereon in a conspicuous place.

Another of his duties is to keep cautioning miners to be careful while trimming the face after firing a blast and to report any person who neglects to notify men in the immediate vicinity when he is about to fire a blast.

Inspectors are to impress on miners the importance of sounding the roof and testing for gas in the morning before commencing work and before and after firing each blast during the day. Miners are to be reported who break the rules relative to explosions such as firing two shots at the same time; who carry dynamite and caps at the same time except when taking them to the face to be used; who leave fuse, caps, and exploders in the same box with dynamite; who make holes in dynamite with a file or spike in order to insert the cap; also miners who crimp caps on fuse with their teeth, and who disregard the rule prohibiting the use of black powder and dynamite in the same hole.

Inspectors are to explain to the miners that they must keep their powder in a box, and not leave it alongside the road, also that all tamping is to be done with wooden bars and not with iron, steel, or a needle.

They are not to allow miners to leave wires attached to a blasting battery, but warn them to disconnect after the shot is fired; and they are to report any violation of this rule as well as report all miners who use a blasting barrel instead of a fuse. It has been proven a dangerous practice for miners to insert a cap in the barrel and then explode it with a squib.

Miners are not to leave safety lamps at the tool box, but must have them at their working face. The inspector is not to permit persons when placing relief timber to remove the old set before the new is inserted and must be sure they lag and also sprag where necessary. Persons are not to leave lumber, boards, or timbers with projecting nails in any place and the inspector is to see that this rule is lived up to. The inspector is to report all slopes that do not have safety holes, and all doors, frames, and other structures erected too close to the rail. All unguarded trolley wires that men pass under are to be reported, and all frogs and switches not properly blocked. Some of the inspector's duties are to see that all passageways are kept free from obstructions; to caution workmen and others not to stand between rails and attempt to board moving locomotives or cars; and to report all persons who ride on cars unless their duties require it. One of the principal duties of the inspector is to caution employes of dangerous practices, such as carrying a naked lamp into districts where locked safety lamps are used or naked lights are

prohibited. It is the hope of the management through the help of the inspectors to educate the employes by personal attention and instruction to care for themselves and to teach that thorough and efficient examinations and inspections before accidents gives better results than where the same work is done after an accident.

Explosion at Neumühl Colliery

The coal field is exploited by shafts 1 and 2 and four levels. The Beckstadt seam, in which the accident occurred on August 20, 1912, dips slightly from the south to north and is worked from the fourth level. It is from 37 to 40 inches thick and consists of coal rich in gas which, despite good ventilation, is occasionally given off in large quantities. Shortly before the explosion, in which three men lost their lives, the working had, on account of complaints of its wetness, been inspected by two of the officials. The observations made had shown that no considerable quantity of gas was present, and a notice board declaring the place to be "gas free" was accordingly hung up. The three men at work there had filled a car, and two of them had started on their way out, while the third had hung his benzine lamp on the timbering under the roof just above a feeder of water, and was collecting the tools with the intention of following. What then followed rests on conjecture. The water from the feeder hole probably gave place to gas, which ascended to the lamp and became ignited. The gas would, at first, burn without explosion, but the fire would be quickly communicated to collections of gas at spots somewhat further away, where the proportions of air that favored explosion were present. Two explosions occurred, and the three men were suffocated by the afterdamp. Considerable damage was also done to the timbering, ventilating appliances, and roadway.—*A. R. L. in Trans. I. M. E.*

OBITUARY

ARCHIBALD F. LAW

Archibald F. Law, former vice-president of the Temple Iron Co., died at his residence in Scranton, Pa., on July 18.

Mr. Law was born June 21, 1856, in Pittston, Pa. He was a grandson of Archibald Law, a Scotch mining engineer who came to America in 1830, and who was very prominent in the early development of the Northern Anthracite Field, and who introduced many of the ideas and general systems still used in mining

Archibald F. Law

in that field. On his maternal side he was descended from the Atwater family, one of the colonial families of New England. He was educated in the public schools and was prepared for college by private tutors, but instead of taking a collegiate course, he entered the employ of the Lehigh Valley Railroad Co. as a weighmaster and held that position for 6 years.

In the year 1879 he went to Buffalo, N. Y., as cashier for the Canada Southern Railway and remained there till 1885, when he became associated with Simpson & Watkins, coal operators, of Scranton, Pa., as cashier and confidential agent. He later acquired an interest in the firm, and when its holdings were sold to the Temple Iron Co. in 1889, he was made secretary of that company. Shortly afterwards he was appointed treasurer and later was made vice-president and manager.

Mr. Law was also president of the Cross-Engineering Co., of Carbondale, Pa., was a director of the Title Guaranty and Surety Co., the Scranton Trust Co., the County Savings Bank of Scranton, the Peckville National Bank, and several other important corporations. He was also a director of the Pennsylvania Oral School for the Deaf, located in Scranton, and was a member of the Advisory Board of the Hahnemann Hospital.

He was also a member of the American Institute of Mining Engineers, the Engineers' Society of Northeastern Pennsylvania, and of the Society of Social Insurance of Paris, France. Socially he was a member of the Scranton Club, the Country Club of Scranton, the Green Ridge Club of Scranton, the Westmoreland Club, of Wilkes-Barre, Pa., and the New England Society of Northeastern Pennsylvania.

He was a member of the Green Ridge Presbyterian Church; and belonged to the various Masonic bodies, up to and including the thirty-second degree Ancient and Accepted Scottish Rite. Mr. Law's pleasing personality, and most courteous manners won him the good-will of all with whom he came in contact, regardless of their station in life or whether they were business or social associates. All who knew him appreciated this trait of character in "Archie" Law as he was affectionately known to most men.

His illness was of comparatively long duration, and was unquestionably aggravated by the sad death of his daughter Grace and her husband, Frank B. Rutter, in the New Haven Railroad disaster last September. He is survived by his widow, who was Miss Eva G. Brenton, of West Pittston, and one son, Frank F. Law, of Scranton.

The Modern Manufacture of Coke

Compounds Formed in Coking—Removal of By-Products—Coke Oven Construction

*By Charles Arnu**

THE author states that French iron manufacturers have to buy from foreign countries about two-fifths of the coke they use, or about 2,400,000 tons. This quantity will soon be increased on account of the extensive increase in French iron manufacturing.

In order to become independent from outside sources, some iron manufacturers have invested in Belgian coal companies that work the new basin of the Campine, and others are planning to coke coal from the German collieries in the Ruhr basin, as they are interested in coking plants that will be built in the East.

Carbonization.—If coal is heated away from air, decomposition of the organic matter occurs and the formation of complex and multiple compounds takes place.

First, the disappearance of the hygroscopic water is noticed, then around 392° F. the decomposition of carbon hydrates and of the ulmic compounds. The formation of chemical water and tar compounds, which are heavy hydrocarbons, rich in carbon, becomes very active around 572° F. and it continues until 842° F., but is entirely completed at 932° F.

At 752° F. the tars are freed. They are mixed with gases produced by the dissociation (at 932° F.) of certain hydrocarbons that are formed with acetylene C_2H_2, ethylene C_2H_4, and some higher terms of these series not saturated and also with a methane CH_4 product of a more advanced dissociation, which appears under the form of a deposit of carbon.

At the same time, at about 842° F., the hydrocarbons, not saturated, polymerize and condense, originating the aromatic series. Then condensation and polymerization cause the appearance of a new series of compounds: Naphthaline, anthracene, xylene, toluene, cumene, etc.

When the temperature rises, this dissociation continues, the gases become poorer in hydrocarbons not saturated, and the formation of graphite begins. At 1,472° F. the CH_4 diminishes gradually and is replaced by hydrogen and carbon, which are the extreme terms of the dissociation.

Finally at from 1,742° F. to 1,832° F. the volatile matter is eliminated and the fixed elements remaining are united together by the deposits of carbon from the dissociation of the hydrocarbons and the ashes from the treated coal, in short, this constitutes the coke.

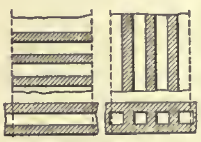


FIG. 1. HORIZONTAL AND VERTICAL FLUES

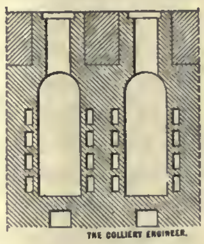


FIG. 2. FLUES OF SOLVAY OVENS

As far as the nitrogen of the coal is concerned, it is but slightly modified before 732° F. to 832° F. is reached, but at that temperature ammonia begins to appear, and its formation active between 932° F. and 1,292° F., is continued beyond 1,616° F.; but from 1,112° F. part of it is decomposed.

Dampness and slow heating increases its production.

Cyanogen is derived from ammonia, and high temperature is favorable to its formation. Also at high temperature coke fixes nitrogen.

Sulphur is eliminated in various ways, according to the nature of the ashes, nearly 30 per cent. of it is eliminated as volatile matter under the form of hydrogen sulphide, sulphur dioxide, and carbon disulphide.

It is to be noted that all products obtained, at first, at the incipient state, react one on the other at various temperatures, thus forming more or less complex compounds.

The physical qualities of coke, homogeneity, hardness, and compactness, are obviously connected with the dissociation of the hydrocarbons that are formed at the beginning of the heating.

Therefore, it is profitable to increase this dissociation by raising the temperature quickly in order not to stop their distillation before 932° F. is reached. A quick heating is also favorable to the output of gas, benzol, and ammonia. For instance, near the walls where heat is transmitted promptly, the coke is of a better quality.

To produce a good quality of coke it is necessary to heat the ovens very strongly in order to increase the distillation of the hydrocarbons. To carbonize crushed coal containing from 8 to 12 per cent. water it is also necessary to increase the homogeneity and density of the mass in such a way that the union of the particles of coke be made easy on account of their being close. For these reasons it is obvious that tamping should still better the quality of the coke.

However, it is to be noted that the chemical composition of the coal must be favorable to this dissociation. For example, dry coal, being richer in oxygen than the coking coal, promotes to the detriment of the hydrocarbon distillation, the formation of CO_2 and CO and also of tars containing oxygen, and large quantities of phenol, which escape promptly at the beginning of the heating because of their being more volatile than the heavy hydrocarbons. Besides, the violent disengagement of the gases that occur at the start makes the coke spongy and friable.

Removal of the By-Products.—The required conditions for obtaining

*Bulletin de l'Association des Ingénieurs de l'Institut Industriel du Nord de la France, July, 1913. Translated from Revue de Metallurgie by A. Courtin, B. A. and B. Sc.

good coke are therefore favorable to the formation of by-products, except tar, but up to 932° F. only; for above that temperature ammonia is decomposed and generation of the hydrocarbons occurs. Therefore, heating must be moderate at the top of the oven where all these gaseous products collect, and it is necessary to remove them from the oven by exhaustion.

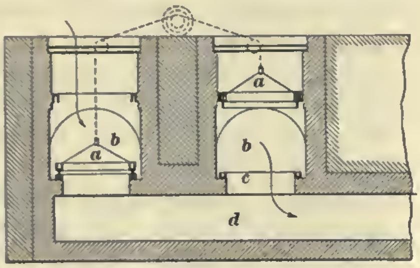


Fig. 3. Reversing with Bells

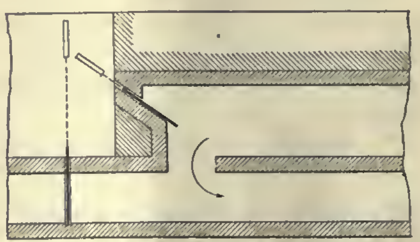


Fig. 4. Reversing with Coupled Dampers

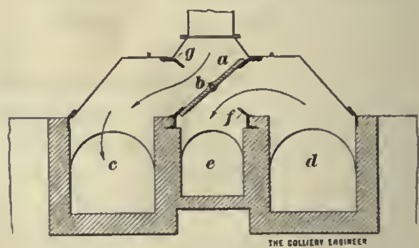


Fig. 5. Reversing with Butterfly Valves

General Distribution of the Heat. In an experiment made on a battery of ovens to ascertain the heat lost, the author obtained the following results in connection with the distribution of the heat furnished by a kilogram of coal (1,400 calories in the gas for each kilogram of coal):

	Calories	Per Cent. of Total Calories	Per Cent. of Total Loss
Loss on account of radiation	246	17.60	35
Loss in the coke, red temperature	136	9.7	20
Loss in distillation of gases	180	12.09	30
Loss in smoke	99	7.1	15
Heat used (excess in gas and lost flames)	739		

COKE OVEN CONSTRUCTION

Horizontal and Vertical Heating Flues.—At the present time, the ovens with horizontal flues seem to be superseded by the ovens with vertical flues, sketch sections of which are shown in Fig. 1. The former can be watched more easily, but the flues not being reenforced with cross-pieces are liable to collapse easily; further it is difficult to regulate the consumption of the heating gas, and finally the horizontal flues of a pier being long and "placed in series" have a small equivalent section and therefore a strong vacuum pressure is necessary to produce the draft. So far as the vertical flues are concerned, if the combustion is more difficult to control, it is easier to have it regular on account of the short distance the flame travels, and as the two sides of the pier are joined with bricks forming the walls of the flues the full section and the rigidity of the mass is such as to increase the solidity.

The vertical flues of an oven being short, numerous and parallel, have a large equivalent section and require only a slight atmospheric depression to produce the draft. Therefore, the direct passage of the gas from the retort chamber through the joints of the bricks is less to be feared. This arrangement increases the output of the by-products; besides, the chimney does not need to be so high.

From the comparison between the horizontal and vertical flues, it appears that the required qualities of a good heating chamber are solidity, proper transmission of the heat, simplicity, affording little resistance to the passing gases, tightness, the facility of watching and regulating, and uniform temperature during the coking process.

In this connection it is to be noted that to obtain at the same time the solidity and the proper transmission of the gases, through walls not very thick, Solvay divided the piers as shown in Fig. 2 into two heating sections by means of a strong wall placed in the middle, on the sides of which light horizontal flues are connected.

The burners used for this purpose are different according to the systems adopted in controlling the admission of the gas, of the air, and of their mixture.

The gas is brought near center of the combustion in each flue most of the time by means of canals made of fireproof masonry, the holes in which are calculated in such a way that each of them furnishes an equal amount of gas. According to the kind of oven, these holes have a section constant or variable from one point to another, or may be regulated at will.

The admission of the air is generally regulated by the draft. By varying the section of the flues, by limiting the number of flues to be fed from one chamber and by means of individual valves, it is possible to distribute the draft equally among all the flues in the same pier.

The mixture to produce flame is accomplished by the proper disposition of the pipes conducting the air and gas. This can be easily done in ovens without regenerators, by means of a Bunsen burner of large dimensions, the admission of cold air being regulated by means of a butterfly valve (Otto's oven) or by means of a little conduit (Coppée's oven).

In the ovens with regenerators, bricks of a complicated form allow the mixture of gas and air.

The heat in the flues between the oven walls is regulated by means of an independent damper or a gas cock, which opens the communication with the main canal that carries waste heat to the boilers or to the regenerators.

Regenerators are intermittent except in the Solvay system, in which the regenerator is continuous. The use of the intermittent regenerators

necessitates the periodical reversing of the draft. For this purpose various devices shown in Figs. 3, 4, and 5, are used. It is also necessary in most of the systems to modify the apertures admitting the gas. These are often double, therefore half of these apertures are to be closed and the others open immediately afterwards.

To perform this operation at one time, each aperture is provided with a cock, the lever of which is fixed to an endless cable, that goes round the battery of ovens and is wound on a windlass. Some ovens having only one set of burners, do not require this reversal for the admission of the gas (Simplex), in some others the work of the regulators and the cocks can be produced by one operation only (Still).

To preserve the rigidity and avoid dangerous deformations, the oven ends are supported by two substantial abutments, made of masonry, and connections between them are by means of tie-rods; in the same way, braces are fixed to the end of each pier.

In order to reduce the loss of heat by radiation, the arch is lined with a masonry work of red bricks, about 1 meter thick; sudden coolings, that might cause cracks in the piers, are thus avoided.

On the contrary, the piers at the extremities of the battery, heating only one oven, are subject to abnormal raise in temperature that may cause the melting of the masonry. This is remedied by creating a circulation of air between the pier and the abutment through flues made for that purpose.

Refractory materials must fill three conditions: expansion, hardness, infusibility.

Silica alumina bricks containing from 80 to 90 per cent. of silica, the remainder being mostly alumina with very small quantities of lime, iron, and magnesia, are generally used.*

(*a*) Expansion should not be more than .75 per cent.; it is caused by the addition of grains of silica in the pug.

(*b*) *Hardness*.—It is obtained by having a homogeneous pug, with fine grains, and by introducing the silica in the form of silicious sand previously cooked then crushed.

(*c*) *Fusibility*.—The proportion of silica SiO_2 and alumina Al_2O_3 gives the wanted fusibility.

Required Guarantee for the Refractory Materials.—Bricks, considering the minimum point of fusibility, may be divided into three classes:

(*a*) Pier and heating flue bricks, up to two-thirds of the height of the oven, are to withstand temperatures as high as 3,182° F.

(*b*) Bricks for the floor flues of the oven are to stand a temperature of 3,074° F.

(*c*) Bricks for the top of the ovens, 3,002° F.

Finally, the dimensions of the bricks must be exact at from 1.5 to 2 per cent. more or less, as a maximum allowance, and faces and edges must be perfectly straight.

*Note.—In this country 96+ silica bricks are used in coke ovens.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Igneous Rocks and Their Origin, by R. A. Daly, Sturgis-Hooper Professor of Geology, Howard University. This book is divided in three parts. Classification of Igneous Rocks, Cosmical Aspects, and Clans. It represents a very large amount of original work, but, necessarily, as it is based on the supposition that geology is an exact science, the results of others are included in the text to meet every possible contention of the skeptic. From this the reader will understand that Professor Daly has not preconceived an idea which he is trying to unload on an unsuspecting public, as did some one on the Origin of Petroleum, although the title of the book is rather suggestive in that line. The book contains 205 illustrations, numerous tables and references. It is published by the McGraw-Hill Book Co.; New York. Price $4.

Metallurgy of Copper, by H. O. Hofman, E. M., Met. E., Ph. D., Professor of Metallurgy in the Massachusetts Institute of Technology. The aim of this book according to Professor Hofman has been to furnish a treatise on copper which will meet the demands of the metallurgist of today, and to this end the discussion is confined to essential points. The text is compiled in the main from material that has appeared in technical journals, scientific societies, and textbooks, but in such a manner that it becomes useful to a greater extent than where it is piecemeal. The book contains 556 9″×6″ pages and 548 illustrations. Published by the McGraw-Hill Publishing Co., New York. Price $5.

Hydro-Electric Power Plants. Stone & Webster, Constructing Engineers, of Boston, Mass., have printed an album showing various hydro-electric power plants, also giving the data in connection therewith. The book will be of interest to most engineers even if not in this particular line of hydraulic and electric engineering.

The Relative Corrosion of Iron and Steel Pipe as Found in Service, by W. H. Walker, Ph. D., and F. N. Speller. From the investigations of these men, and Prof. Ira H. Woolson, there is on an average no difference in the corrosion of iron and steel pipe. The illustrated discussion by the authors is in No. 10C, National Bulletin, which can be had of the National Tube Co., Pittsburg, Pa., on application. All interested in pipe should send for a copy.

Society Meetings

The American Mine Safety Association will hold its annual meeting in New York, September 7-10, inclusive, at the Waldorf-Astoria Hotel, 32d St. and Fifth Ave. On September 12 the Association will hold its annual field contest in con-

nection with the Coal Operators' Association of Indiana, at Terre Haute, Ind. Exercises will begin at 10 A. M.

The Coal Mining Institute of America will hold its winter meeting in Pittsburg, Pa., December 8 and 9. Headquarters will be at the Fort Pitt Hotel.

The Point of Human Contact

By a Southerner

It is the rule and religion of the Mohammedans that the superior must always speak first to the inferior in rank or station. The man riding must be the first to greet a man walking; a man on horseback must be the first to salute the man on a donkey; the man on a camel must speak first to the man on a horse.

Need we argue that this is a splendid rule of life? Does it not keep one from unconsciously adopting an attitude of superiority by merely insisting that he must speak to *all* men and be the *first* to address those of lower rank, thus adding courtesy and kindness to his mode of life? Such a rule of greeting is a fine leveller of a lot of class distinctions.

What about the point of human contact in mining operations? How much trouble might have been and may be saved by a study to discover the point or place where the operator and the operative touch or come in contact and of how this contact may be made more pleasant and lead to better, truer understanding?

As to how this contact is made in most instances, the memory of a conversation overheard in the time office of a Southern coal mine concern is typical of far too many more: It was pay day; the statements carrying full detail of earnings and stoppages were being given out to the miners, most of whom were negroes.

To detail a pay statement for a negro who can barely read and write is to invite requests for a full explanation of all the figures on it. Give him a statement of total earnings, total stoppages, and balance due, and he will be tickled to death to trust to "de w'ite folks" for its correctness.

At another window the assistant timekeeper, or pay-roll clerk, was busy making explanations in about this wise:

"What do you want, nigger?"

"Cap'n, dis here statement got me docked fo' slate. I sho didn't load none."

"Well, the slate report said you did. You got more money now than you usually draw. Get on out of the way."

The negro, of necessity, goes to the pay window, cherishing a grudge because the timekeeper didn't show him that he did load slate and explain all the facts in connection with the dockage. The timekeeper addressed him as "nigger," although he knew his name. That didn't do any good, either.

No. 2 comes along:

"Cap'n, I'se cut for doctor. I doan need no——"

"Well, don't you live in the limits?" (Meaning in the zone of treatment by company doctor.)

"No sir, I lives in de white folks' yard."

"Well, you're cut for the doctor; don't care where you live."

During the course of the pay, probably 20 or 30 men come up seeking explanation of something they can't clearly understand, and in far too many cases little or no explanation is given and the men go away feeling it is all wrong. The manner and tone of address on the part of the timekeeper is directly contrary to the religion of the Mohammedan. It is curt and supercilious when it should be courteous and explanatory in the true sense of explaining things.

It is true of nearly every coal mine that the time office is the chiefest place of human contact. Here the men who work for themselves come in contact with the men who work for the company and who must, to the men themselves, be representative of its management and spirit. Most companies seem to work on the principle that the worst a timekeeper can do to them is to put "straw men" on the roll and get away with some money. Far from the mark. The worst they can do to you, Mr. Mine Owner, Manager, or Superintendent, is to sow seeds of discord, distrust, and dislike for your methods which will bear fruit in lower efficiency, complaints, and even in strikes. There is good reason to fear that a lot of bad spirit on the part of the men can be attributed to the way they have been treated at the time-office window.

As far as the Southern negro is concerned, there is no doubt that what is called "talking back" to the white man is really the effort on his part to present his own side of the question in any way. He is addressed as "nigger" when to call him by name or even in a kindly manner as "old man," will in ninety-nine cases out of a hundred gain his confidence instead of arousing his distrust.

As far as the South is concerned, the negro miner is rapidly becoming the largest factor. His treatment and well being are receiving the best of attention from those concerns who are in the least progressive. To gain his confidence by fair and considerate treatment; to look after his well being by whatever training is possible toward improving his conception of the value of a dollar, to protect him as far as possible from loan sharks and those who would prey on his ignorance; to afford better living conditions, schools, and church facilities, is the purpose and practice of every live concern. This is especially true of the larger companies who can better afford through good times and bad to carry on expensive welfare and betterment work.

But whether the man who works for you is black or white, remember there is a point of human contact and make it a policy of your management to see that your men are treated like men so far as the human side of things is concerned.

Apply the Mohammedan's religion to your foremen and timekeepers

and have it understood that whenever and wherever they come in touch with the men, they must speak first and speak kindly. You'll be glad you did it.

Notes on Mines and Mining

ILLINOIS

Superior Coal Co.'s Record.—The three mines of the Superior Coal Co. in Macoupin County, Ill., in the central part of the state, produced for the year ending June 30, 1914, 2,534,312 tons of coal, worked 222 and a fraction days, and averaged 11,383 tons per day.

Mine No. 1, produced 754,993 tons, hoisting 217⅞ days, and averaging 3,565 tons per day.

Mine No. 2, produced 887,863 tons, hoisting 225⅛ days, and averaging 3,944 tons per day.

Mine No. 3, produced 891,457 tons, hoisting 224 15/16 days, and averaging 3,961 tons per day.

The record for production is not the only thing to commend at these mines; for instance, there were three fatal and 23 non-fatal accidents for the year, the non-fatal accidents considered were only those which caused the loss of 30 or more days' time. No. 2 mine has not had a fatal accident for nearly 2 years, and in that time has produced nearly 2,000,000 tons of coal.

The production per fatal accident for the year just closed, for these mines was 844,820 tons, as compared with 782,591 for the year 1913. The average for the whole state for 1913 showed 352,407 tons mined for each life lost. The production per non-fatal accident for these mines in 1913 was 110,194, and the average for the state was 60,338 tons.

These mines have made a very good record since they were opened, and it would not be surprising if the year 1915 surpassed the record of 1914.

John P. Reese, general superintendent, and John Ross, his assistant, at Gillespie, are active in the "Safety First" movement, and are sincere in their efforts to bring about a new order of things, whereby mine accidents can be reduced to the minimum, and suffering therefrom be decreased.

Rescue Station Examination.—The State Civil Service Commission of Illinois will hold an examination at the Mine Rescue Station, Springfield, on September 5, 1914, to provide an eligible list of persons qualified to act in the position of Assistant at the three mine rescue stations of this state. located at LaSalle, Springfield, and Benton. The salary limits are $75 to $100 a month, and the age limits are 21 to 50 years. The examination, which will be mostly oral, will take up the training and experience of the applicant and will include questions and practical tests on the use of mine rescue apparatus, mine fire fighting, helmet work, first aid to the injured, and methods of preventing mine fires and accidents, and will include a very rigid physical examination.

PENNSYLVANIA

High Price for Coal Land.—W. H. Warner, of Cleveland, Ohio, recently purchased 262 acres of coal land in Washington County, Pa., about 6 miles from the town of Charleroi, along the Monongahela River, and within reach of the Monongahela division of the Pennsylvania Railroad.

For one farm of 187 acres, Mr. Warner paid $1,100 per acre for the surface and the Pittsburg coal seam, and for the other 75 acres he paid $900 per acre for the underlying Pittsburg seam without the surface right. In both tracts the Freeport seam was reserved by the sellers.

On July 28, Alexander Babbo, John Sado, Frank Conwal, Nick Kondar, Andy Kondar, Peter Bedik, Joe Sabato, Mike Sabato, and Mike Spelich, miners employed at Ralphton No. 3 mine of the Quemahoning Coal Co., near Somerset, Pa., were each fined $28 in a justice's court for violating the state mining law. They were prosecuted by Mine Foreman Charles Olsen and Assistant Mine Foreman Royal Shaffer, under direction of Mine Inspector Cunningham for failing to prop the face of their working places as required by law.

The Frick Veterans' Association, consisting of officials of the H. C. Frick Coke Co., who have been in the service of the company for at least 20 years, held its annual picnic on July 23, at Idlewild Park, in the Connellsville, Pa., coke field. It was estimated that almost 2,000 people attended. The officers of the association are W. A. Todd, of Scottdale, president; P. J. Tormay, of Connellsville, vice-president; and C. B. Franks, of Leisenring No. 1, secretary.

TENNESSEE

The Chattanooga Manufacturers' Association recognized its tenth anniversary by presenting the secretary, Oscar L. Bunn, with a 1915 model seven-passenger automobile. The association owns its own house and has 155 exhibits of the city's products on hand for the inspection of visitors. Among the most interesting exhibits, although the product permits very little elaboration, are those of the Etna Coal Co., Durham Coal and Iron Co., Sewanee Fuel and Iron Co., and Chattanooga Iron and Coal Co. They are eloquent of the mineral resources of the Chattanooga district, where 20,000 tons of coal are mined daily. The Nixon Mining Drill Co., of Chattanooga, also has a varied exhibit of the high-grade mining appliances.

W. Va. Pays Compensation.—As rapidly as proofs of claim are filed the workmen's compensation division of the Public Service Commission is paying the claims growing out of the explosion of the Eccles mine of the New River Collieries Co., April 28, when 180 men lost their lives. Thus far 61 of the cases have been completed and the dependents are being paid. Up to August 1, pensions to the amount of $4,224.55 had been paid to those dependent on victims of the disaster, and the payment of pension claims each month now amounts to $1,545.86. The compensation division paid out $4,224.55 in funeral expenses following the accident.

WITH THE EDITORS

WE SOMETIMES meet men who know all about coal mining. That is, they think they do. Such men will not agree with President Wilson's remark that *"No student knows his subject. The most he knows is where and how to find out the things he does not know with regard to it."* Of course the man "who knows it all" resents being called a student, and he certainly isn't one. But the men who "get there" in the mining industry—the men who produce great results—never cease being students. They eagerly absorb useful knowledge from every available source, and then apply it.

THE opening of the Cape Cod canal on July 29, confers a great benefit on shipping plying between Atlantic coast ports and those of a large part of the New England coast. While the draft limit of the canal is now only 15 feet, it will be increased by dredging to 25 feet. In the meantime steamers and barges drawing 15 feet or less can pass through. By the elimination of the route around Cape Cod, time and fuel will be saved and vessels using the canal will escape at least 50 per cent. of the bad weather so often encountered in sailing around the cape. The freight tonnage that heretofore went around the cape aggregates over 19,000,000 tons per year. Of this, 11,000,000 tons represents the coal tonnage. The canal is a sea level one and therefore requires no locks.

ALABAMA produced 17,678,522 tons of coal, valued at the mines at about $20,000,000, during the year 1913. Her coal resources have made her an important industrial state, and she enjoys twice the prosperity she would have if she had no coal. Notwithstanding this fact, she provides no funds to pay for the printing of the State Mine Inspector's Report.

The only way in which the Report can be published is by a private printing house agreeing to publish it, provided "we can secure enough advertising matter and subscriptions from the various coal and iron operators to justify the expense, and we earnestly request that you aid us in the matter by contributing whatever amount your best judgment dictates."

The foregoing quotation is a verbatim extract from a circular letter sent out by the printers, who are to be commended for their enterprise. But, what excuse can be made for the state of Alabama? A sovereign state posing as a pauper! Southern pride—where is Alabama's?

Safety First

CHIEF Inspector of Mines of Pennsylvania, James E. Roderick, made the suggestion that the anthracite collieries of his state appoint company inspectors in order to reduce the fatality rate. This method of inspection was put in operation by the Susquehanna Coal Co. in June, 1913, and after 1 year's trial has reduced the number of fatalities in the proportion of from 8 to 1 reckoned by the tonnage produced per fatal accident.

On another page is given an abstract of the duties of the inspectors as decided on by Manager Robert A. Quin, and it is believed that those who read this article will agree with us that the miners who opposed a similar system of "patrol" instituted by Colonel Phillips, manager of the Delaware, Lackawanna & Western Coal Co., were most unreasonable. In fact, when the matter came officially to the attention of the district officials of the United Mine Workers, they promptly and effectively disapproved of a threatened strike on the question.

Political Inconsistency

THE inconsistency of the politicians at Washington, who pose as representatives of all the people, but who trim their actions to cater to the prejudices of elements whose votes they want, is evidenced by the following press dispatch to the *New York Times*, from Topeka, Kans., under date of July 18:

"Kansas farmers will hold back 100,000,000 of their 193,000,000 bushels of wheat this year, according to W. H. Mitchell, national vice-president of the Farmers' Society of Equity.

"Mr. Mitchell is organizing the farmers of Kansas and urging them to hold their immense crop for higher prices. Sixty-cent wheat in Kansas has become the rule, and has turned the thoughts of the farmer to the possibility of holding his grain. When the organizers arrive in a community they find little opposition to the idea of organized holding, according to Mr. Mitchell.

"'I do not believe that more than one-fourth of the wheat grown this year will be sold at once,' said Mr. Mitchell.

"The Farmers' Society of Equity is campaigning for dollar wheat, but the Kansas members will sell their grain for less than that figure, it is generally believed. Most of them are preparing to hold for a higher price than the 60 odd cents now offered."

This action of the "honest farmers" is the natural result of recent legislation by Congress, when in passing

the bill appropriating funds to secure the enforcement of the "Sherman Law" providing for the abolition of associations formed for restraint of trade, it was ordered that no portion of the appropriation should be applicable to the prosecution of certain classes of organizations, including farmers.

According to the present United States law, it is criminal for the owners of coal mines, as well as other business interests, to organize with the object of overcoming ruinous competition and to fix a reasonable price for their products, whereby they can afford reasonable wages to employes and secure a fair profit on their invested capital, but it is entirely righteous for the farmers to organize a trust in wheat which will force the price of flour to a figure that will be burdensome to every wage earner in the country, and which will entail suffering on the poorer classes.

Consistency is a jewel that is remarkable for its rarity among the majority of the politicians at Washington.

Coal Mine Regulation

IT HAS been stated that the present development of bituminous coal mines in the United States would, if worked to full capacity, produce twice the quantity of coal the market demands. If this premise be true, one need not feel astonished that overproduction causes decline in prices through destructive competition. However, be that as it may, some of the suggestions advanced to overcome the situation are astonishing, as they vary from the governmental confiscation of coal property to allowing only large corporations to mine coal.

A member of the Illinois Coal Operators' Association believes the German system should be applied by our Government, which is, "that no new mine should be opened unless the Government sees a need for it." In opposition to this, the West Virginia Public Service Commission is hearing complaints from northern West Virginia coal land owners, who assert, among other things, that the Buckhannon & Northern Railroad Co. is conspiring to prevent the opening of mines by the small operators along its recently constructed line, and the Commission is asked to interpose its authority and to permit coal developments to be free and unrestrained.

While this is in progress we are informed that the Coal and Coke Railroad Operators' Association, in West Virginia, has taken steps to compel the railroads to furnish a fair number of cars to haul coal to market; to furnish adequate switching facilities, and to make a tariff that will be just to the operator and consumer.

One writer states that "the only method of approaching efficiency in dealing with competition is through large operating companies who cannot as a rule afford to sell below cost." Although the paragraph is as definite as a lawyer's, we presume the writer means that the large operating companies should not sell below cost; and with this version we agree, because during the last 3 or 4 years such coal companies as have gone into the hands of receivers have been large operations which, on the rocky edge of disaster, have been underselling other operators in the hope of tiding over their troubles by ready cash.

The history of the Pittsburg coal trade shows that the small operator who works a drift mine is better able to withstand financial stress, when accorded fair treatment by railroads, than the large coal operators, and that the only possible way of getting rid of him is to buy his property. Those large corporations that have attempted to put him out of business by underselling have found that plan abortive and expensive; for he is able to mine cheaply, and when coal reaches a price which is unprofitable he ceases production and again starts to mine when the price is profitable. In some cases in the past, railroad officials have antagonized and interfered so much with some operators that they have met with financial disaster, and as this was done in the interests of railroad officials connected with competing mines there has been grave injustice done. This state of affairs will be rectified speedily, for in July the Interstate Commerce Commission recommended that the railroads in Illinois should separate their private from public business, and should be prohibited from furnishing, directly or indirectly, capital or loans to private industries, and that railroad officials should be enjoined from extending or using company credit for the benefit of the private individual or coal company. The report also gives a long list of railroads owning bonds and stocks in Illinois coal companies.

Another common suggestion advanced is that coal operators be allowed to combine, and by this means reasonably curtail production and steady the market. Those who made the suggestion, admitted that the plan would be illegal under present laws, but that the laws could be modified so that the amount of restriction and prices asked could be regulated by a competent government commission.

Some years ago an agreement was entered into between Pennsylvania and West Virginia coal operators not to sell coal below a stated price. A prominent Wall street banker was instrumental in consummating this agreement, but he neglected to have the officers of a company in which he was interested sign with the others. When the New York & New Haven Railroad officials opened the bids for supplying coal to that railroad, they found one company could supply them with 350,000 tons of coal at a less price than the other companies, and the contract was awarded to the banker's company. To make an efficient combination, all coal operators must be included, but we are not quite so near the millenium as that. While it will take time, we believe that coal mining will be placed eventually in a position where each operation will have an open chance to compete in its natural market with every other operation, and that the fittest will survive.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.
The editors are not responsible for views expressed by correspondents.

Carbide and Dust

Editor The Colliery Engineer:

SIR:—In June there occurred at the Crescent mine, Bevier, Ky., a dust disturbance that stopped a part of the mine for about 2 hours. It was not shooting time and no shots were fired, and the dust was on the last of the air, which had traveled about 1 mile and furnished 200 men with air on the continuous current system. On investigation it was learned that a miner passing from one entry to another with a keg of powder had upset his keg where he set it down, and that some of his powder spilled out. He threw a little dust over it and left it.

I would like to know if carbide were emptied from a lamp on top of this and wetted, would it have produced enough heat to set the powder off.

OSTEL BULLOCK
Cleaton, Ky.

Percentages Attained in Examinations

Editor The Colliery Engineer:

SIR:—Where do the Examining Boards in Pennsylvania get their authority to refuse applicants at examinations their percentage marks? There is nothing in the law that says they shall notify them and nothing that says they shall not. I think it has been customary to notify those who have passed and those who have not and give their percentages. The Board in the 19th District refused to give out a young man's percentage mark, and an inspector stated that a man has no business coming to the examination unless he can make 10 per cent. When a man pays his dollar to take the examination he is, in my belief, entitled to know what his percentage mark is at the examination. I have no axe to grind in this matter, but it is a subject I would like to hear others' views on.

W. B. MOODY,
Asst. Mine Foreman
Penn Station, Pa.

Examination Question Correction

Editor The Colliery Engineer:

SIR:—In answer to examination question 27, page 709, June issue, I figure as follows:

(1) 3,000 feet of roadway × 2 = 6,000 feet or 2,000 yards. 2,000 yd. × 20 = 40,000 lb. rail or 20 tons @ $41.50 is $830. I do not see where the $\frac{11}{7}$ comes in.

(2) $\frac{6{,}000}{20}$ would be 300 pairs of splices, + 2 would be 302 pairs instead of 151 pairs, and the price would be $78.52 or double what is given in the answer. With these changes the total cost would be $1,322.80 instead of $1,194.73.

St. David, Ill. C. E. C.

(1) One ton of rails weighs 2,240 lb. and $\frac{40{,}000}{2{,}240} = 17.86$ tons. The factor $\frac{11}{7}$ is obtained as follows:

One mile of road has 3,520 yards of rail. One yard of rail weighing 1 pound per yard $= \frac{1}{2240}$ ton. 3520 yards will weigh $3520 \times \frac{1}{2240} = \frac{3520}{2240} = \frac{11}{7}$ tons. Consequently the number of tons in a mile of track of any rail given in pounds per yard can be found by multiplying the pounds per yard by $\frac{11}{7}$. (2) In regard to the number of joints, you are right.

Data on Grease Accumulation in Air Receivers

Editor The Colliery Engineer:

SIR:—An inquiry made by a reader who signs himself "Compressor Engineer," on page 768, of the July issue, leads the writer to reply thereto as follows:

The air compressor requires lubrication in its air cylinders as well as in its steam cylinders, and both are provided with lubricators for feeding oil into the interior.

In the first place nearly all compressor runners feed too much oil into the air cylinders. No matter how much you explain to them that the air cylinder is not subject to the same scouring action that takes place in the steam cylinders, they still feed it too much oil. If every compressor runner was to shut off 50 per cent. of the oil he uses, he would still be feeding too much.

It doesn't take a great deal of oil for any cylinder, but no matter how small the amount used the heat generated by compression vaporizes some of it which passes into the air receiver and pipe lines. This oily vapor accompanies the compressed air, moisture, and particles of dust that have been drawn in through the intake.

It is customary for most compressor runners to set their steam and air lubricators alike. Sometimes the lubricator keeps on working when the speed of the compressor is reduced with a throttling governor. The amount of oil poured into the cylinder would be just the same when the compressor made fifty revolutions per minute, as when it made one hundred and fifty. Naturally the passage of air through the pipe lines is more rapid in linear feet per minute than it is through the receiver. Hence, the speed of the air is less in the receiver, and furthermore the temperature begins to decrease by the time the air has reached the receiver, and still further, as the air is drawn off for use,

the pressure gauge fluctuates. Thus there are times when the air is less dense in the receiver than at others.

These three items of less heat, less speed, and less density all tend to precipitate moisture, oil, and dust upon the sides and the bottom of the air receiver. Part of this oil becomes sticky and viscous on account of the quantity of dust that has gathered in the oily vapor. This adheres to the interior of the receiver shell and pipe lines, and is frequently the cause of receiver explosions.

Temperatures of compression frequently run from 400 to 450 degrees above the temperature of the intakes. These temperatures will generate more or less oil gas, and in poorer grades of oil will ignite it. Sometimes they form carbon particles which become ignited and are passed through the air passage as sparks of fire.

It is evident that if the receiver is full of oil gas an explosion is likely to follow. It must be borne in mind that there is no such thing as "carbon free oil," and to prove this statement if you will take any of these oils and set them afire, they will make a smoke while burning, which is evidence that there is carbon in the oil. Therefore, the greatest care must be taken not to burn the oil in the compression of air.

This is one of the offices of the water-jacket on the air compressor, and it is manifest that no matter how cold the water might be around the air cylinder, it would probably have no effect whatever in cooling the volume of air in the cylinder with the piston traveling at the rate of 150 revolutions per minute, or less. It undoubtedly cools the metal walls of the cylinder, and thereby keeps the thin film of lubricating oil between the piston and the cylinder much cooler than the air in the center of the cylinder.

It is evident that any excess of oil fed into the cylinder must be vaporized and passed off. It is also true that the necessary oil, no matter how little, must also be vaporized and passed into the receiver, and be replaced by oil from the lubricator. If this was not so the lubricator would not be necessary, for once it is oiled it would stay oiled.

The inquirer also asks if the accumulation of this oily mass can be prevented in the receiver. It cannot be prevented, but it can be reduced by the proper construction of the air receiver. In the first place every air receiver should have a manhole in it so that it may be opened and cleaned with soap and lye water after being scraped as clean as it can be.

Warning! Gasoline, benzine, naphtha, alcohol, and such materials should never be used in cleaning air receivers, as they form gases more dangerous than those of the lubricating oil.

Considerable labor can be saved in the work of cleaning air receivers if they are tapped with a half-inch hole at their lowest point for drainage. This should be at the bottom, and a straight down hole. A half-inch nipple should be screwed into the hole but not allowed to protrude inside the shell. A bushing should then be screwed upon the nipple to bring it up to 4 or 5 inches. On this bushing should then be screwed a 6-inch length of 4-inch pipe, and it should again be reduced to a ½-inch pipe fitted with a suitable cock for draining. This arrangement acts as a trap below the receiver. No matter at what pressure the air is maintained in the receiver the same pressure exists in the trap. Therefore the flow of moisture and oil is into the trap at all times. When the drain cock is open the pressure of the receiver immediately blows out the oil, grease, and water. Without the trap below the receiver it will be found that the air pressure will simply blow a hole through the viscous mass of grease and dust without giving the slow moving coating a chance to drain off.

There is no objection to opening this blow-off from the bottom of the trap every hour if desired, or any way two or three times a day as it is very little trouble to do so. At the same time if the trap is big enough to hold all the moisture and grease that is precipitated it will make no difference if it is opened once a day or once a week. However, every compressor runner must understand that even this will not prevent the oily vapors from sticking to the top and sides of the shell, becoming caked with dust, and still more being precipitated on top of that. This coating in receivers that are not properly attended to will frequently get a half inch or an inch thick, and it must be borne in mind that this coating maintains all the properties for making an oil gas when sufficient heat is applied. If the gas in suspension should become ignited at any time the heat will cause still further gas to be generated from the coating of the receiver.

The violence of the explosion which follows will not be relieved by any safety valve that may be installed in the receiver. The safety valves in air receivers are merely indicators that the pressure is too high, and are installed upon the same theory that they were used upon steam boilers, and are of very little benefit, if any, upon an air receiver, particularly if the compressor is equipped with an unloader.

It is interesting to note that the manufacturers of lubricating oils will specify the flashing point of their lubricant, and further guarantee the oils to be safe for compressor use. However, it is a well-known fact that if a candle is ignited upon the top of a mountain where the air is very rare, it will burn with a weak flame, while if the same candle is taken into a caisson where a pressure of two atmospheres is maintained it will burn with a bright flame and very rapidly. In other words the oxidization is more rapid under pressure than in ordinary atmospheres. It would be interesting to know what the flashing points of lubricating oils would be under 100 pounds pressure. It is quite evident that the combustion and oxidization would be more rapid and violent under pressure than when the oils are tested in open vats.

L. Balliet, E. M. and C. E.

Answers to Examination Questions

Questions Asked at the Examination for First-Class Mine Managers Held at Springfield, Illinois, April 20, 1914

Ques. 1.—What are the laws in reference to persons coming before the Board for certificates of competency?

Ans.—Candidates must produce satisfactory evidence that they are American citizens, at least 24 years old, that they have had not less than 4 years practical experience in mining, and that they are temperate and of good reputation.

Ques. 2.—Commencing at the southwest corner of a piece of land and running a line 1,720 feet north, thence east 2,650 feet, what will be the length of the remaining side and how many acres will it contain?

How many tons of coal are there in the above piece of land, coal 6 feet thick, allowing 27 cubic feet per ton and the specific gravity of coal 1.26, pillars and waste being 35 per cent?

Ans.—The tract is in the shape of a right-angled triangle, of which the remaining side is the hypotenuse. The length of this side is equal to $\sqrt{1,720^2+2,650^2}=3,159.25$ feet.

The area of the tract, in square feet, is equal to one-half the product of the sides, and is $(1,720 \times 2,650) \div 2 = 2,279,000$ cubic feet. The area in acres is $2,279,000 \div 43,560 = 52.31$ acres.

The number of cubic feet in the coal seam is equal to its area in square feet, multiplied by its thickness, or $2,279,000 \times 6 = 13,674,000$ cubic feet. Since 35 per cent. of this is lost in the pillars, the net volume of coal will be $100 - 35 = 65$ per cent. of the original, and $13,674,000 \times .65 = 8,888,100$. Attention must be called to an error in the question. If the specific gravity of the coal is 1.26, 27 cubic feet do not weigh 1 ton or 2,000 pounds, but weigh 2,126 pounds. Using 27 cubic feet to the ton, there are, in the seam under the tract $8,888,100 \div 27 = 329,200$ tons, very nearly.

Ques. 3.—The total rubbing surface of a square airway being 160,000 square feet; the length of the airway 5,000 feet; the quantity of air passing, 80,000 cubic feet per minute; what is the velocity of the air-current in feet per minute?

Ans.—The perimeter of the airway is $160,000 \div 5,000 = 32$ feet. Since the airway is square, the four sides have the same length, and each is $32 \div 4 = 8$ feet long.

The area of the airway is $8 \times 8 = 64$ square feet, and the velocity of the air-current is $80,000 \div 64 = 1,250$ feet per minute.

Ques. 4.—How many cubic yards are there in a rectangular shaft 360 feet deep, 12 feet long, and 6.5 feet wide?

What is the total cost for removing the same at $1.93 per cubic yard?

Ans.—The volume of material in the shaft will be $(360 \times 12 \times 6.5) \div 27 = 28,080 \div 27 = 1,040$ cubic yards.

The cost of extracting this will be $1,040 \times 1.93 = \$2,007.20$.

Ques. 5.—What horsepower will be expended in circulating 20,000 cubic feet of air against a mine pressure of 1.75 pounds per square foot?

If the quantity is increased to 30,000 cubic feet, what will be the horsepower?

Ans.—In the first case

$$\text{H. P.} = \frac{qp}{33,000} = \frac{20,000 \times 1.75}{33,000} = 1.06.$$

If the last part of the question refers to the horsepower necessary to circulate 30,000 instead of 20,000 cubic feet of air against the same water gauge of 1.75 inches, this may be found by using 30,000 in place of 20,000 for q in the foregoing formula, and is 1.59 horsepower.

On the other hand if it is required to find the horsepower that will circulate the increased quantity in the same mine, then the power varies as the cube of the quantities, and the power necessary to pass 30,000 cubic feet is $1.06 \times \left(\frac{30,000}{20,000}\right)^3 = 3.58$ horsepower.

Ques. 6.—In what time can an engine of 40 effective horsepower pump 4,000 cubic feet of water from a depth of 430 feet?

Ans.—Assuming a cubic foot of water to weigh 62.5 pounds, the work required in pumping will be $4,000 \times 62.5 \times 430 = 107,500,000$ foot-pounds.

In one minute 40 horsepower do $33,000 \times 40 = 1,320,000$ foot-pounds of work. Hence, it will take the engine $107,500,000 \div 1,320,000 = 81.4$ minutes, nearly, or about 1 hour 20 minutes to clear the sump.

Ques. 7.—What is the breaking strain and safe working load of a good steel hoisting rope, $1\frac{3}{8}$ inches in diameter?

Ans.—From the manufacturers' tables, the ultimate strength of a cast-steel rope of the size named is found to be 56 tons or 112,000 pounds. The safe working load will depend upon the factor of safety selected, which will vary from 5 to 10. Using the lower value in accordance with the common American practice, the safe working load

would be $112,000 \div 5 = 22,400$ pounds. While it is advisable to rely on the rope makers' tables, any one of numerous formulas may be used for calculating the safe working load of a hoisting rope. Thus if

L = proper working loads in pounds;
d = diameter of hoisting rope, in inches;
D = diameter of rope drum, in inches,

$$L = 20,000\, d^2 - 757,600\, \frac{d^2}{D}$$

If the diameter of the drum be assumed to be 7 feet = 84 inches, we have,

$$L = 20,000 \times \left(\frac{11}{8}\right)^2 - 757,600 \times \frac{\left(\frac{11}{8}\right)^2}{84}$$
$$= 37,812 - 17,050 = 20,762 \text{ pounds.}$$

Another formula quite generally used is, $L = 68,000\, \frac{d^2}{f}$, in which L and d have the meanings given before and f is a factor of safety, commonly taken as 5. Substituting in this last formula,

$$L = 68,000 \times \frac{\left(\frac{11}{8}\right)^2}{5} = 25,710 \text{ pounds.}$$

The foregoing formula is only applicable to ordinary cast-steel ropes; for extra strong rope, the coefficient is 78,000, and for plow steel it is 88,000.

Still other formulas are available which will give different values for the working load. As the proper working load depends not only upon the material of which the rope is made but also and very particularly upon the size of drum, sheaves, etc., and as in all cases a large factor of safety is used to guard against unknown strains, it is obvious that the most sensible course is not to attempt to use formulas to calculate either the total strength or working load of a wire rope, but rather to rely upon the manufacturers' tables which are based upon many years' experience with ropes that have been used under all possible conditions of service.

Ques. 8.—(*a*) State the conditions under which mine explosions are most frequently produced?

(*b*) In what way do the various kinds of coal dust influence the character of an explosion?

Ans.—(*a*) Mine explosions may arise from the ignition of either methane or coal dust which have been allowed to accumulate in the mine workings. Methane will accumulate where the air-current is insufficient to dilute the gas below the explosive point and then remove it; where working places have been driven ahead of the air; and when some accident has stopped the fan. The gas may be ignited by an open lamp, by the flame from a blown-out shot, from a mine fire, or by the arc produced through the short-circuiting of an electric current. Which conditions cause the greatest number of gas explosions depends altogether upon local conditions. Probably a majority of gas explosions are caused through general poor ventilation of the mines, with working places driven beyond the air, in which the accumulated gas has been ignited by the flame of a poorly placed, improperly charged, blown-out shot.

Dust explosions arise through the ignition of large quantities of finely powdered and dry coal dusts of certain kinds. Dry coal dust will accumulate in the workings under any conditions, but particularly where the air-currents are large and of high velocity, where the coal is soft and friable, where the coal is shot from the solid, where excessive charges of black powder are used in poorly placed holes, where overloaded and open-jointed mine cars are used, where the entries and rooms are not regularly washed down with water, and where the dust is not loaded out from the working places and the roadways kept clean. Coal dust is ignited in exactly the same way as methane, and it is probable that blown-out shots are responsible for the vast majority of coal-dust explosions that occur.

(*b*) Readily ignitable coal dusts extend the effect of a local gas or powder explosion through the distillation and burning of their contained gases. As each minute particle of dust is surrounded by an envelope of burning gas, the mine dust as a whole acts very similarly to exploding methane. Dusts of coals low in volatile matter, as anthracites, or high in moisture and ash, as many lignites, are not exploded under conditions prevailing in the mine.

Ques. 9.—Explain how you would determine the safe working load for a seasoned hemlock mine prop, 10 inches square and 7 feet long, assuming the crushing load per square inch is 5,300 pounds?

Ans.—As this prop is short in proportion to the area of its cross-section, it will crush before it will bend and its strength is directly proportional to its area. That is,

Total strength = $10 \times 10 \times 5,300$ inch is 5,300 pounds.

As the prop is not subject to live or moving loads, a factor of safety of 3 should be ample, and $530,000 \div 3 = 176,666$ pounds = $88\frac{1}{3}$ tons, may be considered a safe working load.

Ques. 10.—A current of 9,000 cubic feet of air per minute is passing through a regulator, the difference in pressure on the two sides of the regulator is equal to .7 inch of water gauge. How far is the shutter open if it is 1 foot in depth?

Ans.—If

a = opening in regulator, in square feet;
Q = quantity of air passing, in cubic feet per minute = 9,000;
i = water gauge, in inches = .7;

$$a = .00038 \frac{Q}{\sqrt{i}} = .00038 \times \frac{9,000}{\sqrt{.7}} = 4.088$$
square feet.

Since the opening is 1 foot deep, its width must be 4.088 feet, or 4 feet 1 inch, about.

Ques. 11.—In a mine ventilated by a fan, the total quantity of air being 130,000 cubic feet per minute, with the fan running at 70 revolutions per minute, and the water gauge 2.5 inches, at what speed would the fan have to run to circulate 150,000 cubic feet of air per minute, and what would the water gauge then be?

ANS.—If the speed of the fan be taken as proportional to the quantity of air in circulation, $x : 70 = 150{,}000 : 120{,}000$, from which x = the speed necessary to circulate 150,000 cubic feet of air = 87.5 revolutions per minute.

It should be noted that the quantity of air circulated is always a little less than the speed of the fan indicates. Actually, it would require some 90 to 95 revolutions of the fan to produce the larger quantity, but the calculation involves the use of fourth and fifth powers, and the simpler ratio used above with an allowance of 5 to 10 per cent. more than the calculated number of revolutions answers all practical purposes.

For the same airway the water gauge varies as the square of the quantity, or $2.5 : x :: 130{,}000^2 : 150{,}000^2$ $x = 3.32$ inches = water gauge.

QUES. 12.—If the ventilating machine was permanently disabled by an explosion of firedamp, what temporary means would you employ to restore ventilation?

ANS.—If the air, after the explosion, shows a tendency to escape through one of the shafts, a pipe through which steam is allowed to escape, may be lowered into that shaft, and thus stimulate the circulation. If a small fan, such as is used in blacksmiths' shops, is on hand, it may be used, or a wind shield or cowl of canvas may be employed to deflect the surface air-currents down the shaft.

QUES. 13.—What percentage of firedamp, when mixed with air, is necessary (*a*) to show a faint cap, (*b*) to readily explode, (*c*) to be at its most explosive point?

ANS.—(*a*) About 2 per cent. of methane is about the least amount that can be detected by the ordinary fireboss under ordinary conditions. The proportion depends upon the skill of the observer, the kind of lamp and oil used, upon whether coal dust or inert gases are also present in the air, etc.

(*b*) Firedamp will readily explode when there is 7.14 per cent. of methane in the air, and will burn and presumably start a dust explosion when the percentage is as low as 5.5. Two per cent. is very dangerous when the coal dust is inflammable, and the best modern practice demands that the methane in the main return air-current be kept under 1 per cent., the determinations being made by chemical analysis.

(*c*) The most explosive point is reached when the methane in the air amounts to 9.38 per cent.

QUES. 14.—The grade of an incline is 7 per cent. and its length is 2,000 feet. If the rope weighs 4,000 pounds and the loaded car 1,800 pounds, how many cars must there be in a trip to make the plane self-acting?

ANS.—The weight of the empty car is not given, but may be assumed at, say, 1,200 pounds. If friction be assumed as one-fortieth of the weights moved, the following formula may be used,

$$N = \frac{(40 \sin y + \cos y)R}{(40 \sin y - \cos y)L - (40 \sin y + \cos y)C}$$

In this formula

N = number of cars that will balance on both sides of plane;

y = angle of inclination of plane = 40 degrees;

R = total weight of rope = 4,000 pounds;

L = weight of loaded car = 1,800 pounds;

C = weight of empty car = 1,200 pounds, assumed.

The angle of inclination of the plane is found from $\tan y = \frac{7}{100} = .07$, whence $y = 4$ degrees, very nearly. Substituting in the formula

$$N = [(40 \times .06976 + .99756) \times 4{,}000] \div [(40 \times .06976 - .99756) \times 1{,}800 - (40 \times .06976 + .99756) \times 1{,}200]$$

$$= \frac{15{,}151.84}{3{,}227.112 - 4{,}545.552} = -11.5$$

Since the result is negative, the incline cannot be made self-acting, and an engine plane must be used.

The same result may be arrived at by remembering that the net load available in overcoming the various resistances is but 1,800 − 1,200 = 600 pounds, and of this but 600 sin 4 degrees = 41.856 pounds acts vertically, that is, does any work at all. The loaded and empty cars, taken together, weigh 3,000 pounds, and at one-fortieth, their frictional resistance is 75 pounds. From this, the gravity pull of the load 41.856 pounds, is only about one-half the frictional resistance of the cars, whence, it follows that the cars will not even start from a state of rest.

QUES. 15.—A sinking bucket is 4 feet 6 inches deep, 3 feet 3 inches in diameter at the top, and 2 feet 9 inches at the bottom. What is the cubical contents of the bucket, and what weight of water will it hold?

ANS.—The mean diameter of the bucket is (3 feet 3 inches + 2 feet 9 inches) ÷ 2 = 3 feet. Since its depth is 4 feet 6 inches = 4.5 feet, its contents are $(.7854 \times 3^2) \times 4.5 = 31.8087$ cubic feet.

Taking water to weigh 62.5 pounds per cubic foot, the bucket will hold 31.81 × 62.5 = 1,988.04 pounds, or practically, 1 ton of water.

QUES. 16.—A drift is driven with a dip of 3¾ inches to the yard a distance of 455 yards into a hill, the sides of which rise 5¾ inches to the yard. What would be the depth of a vertical shaft to the end of the drift, and how far up the hill would it require to be?

ANS.—Examining boards should not give grades in such antiquated terms as inches per yard, as it needlessly complicates the problem. The method is entirely English and is as slow and cumbersome as English currency. It is assumed that the yards are measured horizontally and the inches, vertically. Since the drift dips at the rate of 3¾ inches and the hill rises at the rate of 5¾ inches, the depth below the surface increases 9½ inches for each yard the drift advances. A shaft to reach the coal at 455 yards from the drift mouth will have to be (455 × 9½) ÷ 36 = 120.07 yards deep. It will be 455 yards from the drift mouth measured horizontally up the hill to the location for the shaft, as stated in the question itself.

Ques. 17.—What is the difference between an angle and a triangle?

Ans.—An angle is the difference in direction of two straight lines which intersect. A triangle is a plane figure bounded by three straight sides.

Ques. 18.—If the temperature of 10 cubic feet of air is raised from 60° to 580° F., what amount of work will be done?

Ans.—Ten cubic feet of air will weigh $10 \times .078 = .78$ pound. If 130 foot-pounds of work are required to raise the temperature of 1 pound of air 1° F., to raise this weight of air through $580° - 60° = 520°$, will require, $.78 \times 130 \times 520 = 52{,}728$ foot-pounds.

Ques. 19.—If the diameter of a circle is squared in feet or inches, what does the product represent?

Ans.—The product resulting from squaring the diameter of a circle represents the area of a square whose side is equal in length to the diameter of the circle.

Ques. 20.—How many pounds of carbon would be required to burn up 100 pounds of oxygen into carbonic acid gas. or carbon monoxide?

Ans.—Burning carbon to carbonic acid gas or CO_2, we have: $C + O_2 = CO_2$. Using the approximate atomic weights, $C = 12$, $O = 16$, $12 : 32 :: x : 100$, and $x = 37\frac{1}{2}$ pounds. The formula when carbon is burned to carbon monoxide is $2C + O_2 = 2CO$. Since the weights of the substances involved in the reaction are proportional to the molecular weights, $2C : O_2 = x : 100$. Using the atomic weights, $24 : 32 = x : 100$, whence x = amount of carbon that will be consumed in burning 100 pounds of oxygen to carbon monoxide = 75 pounds.

A darky, who was driving a balky mine mule and howling between strikes "git up thar circumstances," was asked why he gave the mule that name. He replied "didn't you eber hyar of circumstances ober which we has no control? Yah! Yah! Yah!"

American Mine Safety Association

The following is the program of the Association for its meeing in New York City at the Waldorf Astoria, September 7-10.

September 7. Morning: Sight seeing and getting settled. Afternoon, 2 o'clock: Address of welcome. Reading of minutes. Report of executive committee. Meetings of subcommittees. Evening: Entertainment.

September 8. Morning: Business session. Committee reports. Afternoon and evening: Excursion to Coney Island by boat. Shore dinner.

September 9. Morning: Business session. Committee reports. Afternoon: Closing business session and adjournment. Visit to Museum of Safety in Engineering Societies' Building.

September 10. All-day excursion around Manhattan Island with visit to New York Edison Co. at 38th St. Station, and that of the United Electric Light and Power Co., at 201st St. Station, also to the work of the Public Commission in tunneling the Harlem River.

The Edison companies have developed several exceptionally valuable methods of guarding against shocks from currents of high voltage, and a visit to their works will well repay those who are interested in electrical work. Ladies will be welcome and a special program is being prepared though in all cases the trips to points of interest will be open to both ladies and gentlemen. The trip around Manhattan has been substituted for the advertised visit to the yacht race because that race is deferred for a month, and it is questionable if it will take place at that date.

The field meet will be held at Terre Haute, Ind., on September 12, at Central League Baseball Park. In the evening, there will be a smoker and social session. Dr. J. A. Holmes, director of the Bureau of Mines; J. P. Reese, president of the American Mine Safety Association; Governor Ralston, Mayor Roberts, and others are on the program as speakers.

Every one who is interested in the mining industry is invited to be present at the meet. No admission will be charged. All squads desiring to enter should notify either H. M. Wilson, secretary American Mine Safety Association, or the Bureau of Mines, both at Pittsburg, Pa., or Dr. August F. Knoefel, Terre Haute Trust Building, Terre Haute, Ind. This notification should come through the superintendent of the company by whom the contestants are employed.

Anthracite Section A. I. M. E.

The Anthracite Section of the American Institute of Mining Engineers held an elaborate meeting in Pottsville in July, at which time W. G. Whildin, division superintendent of the Lehigh Coal and Navigation Co., read a paper on "Long Chute Mining Applied to Thick Coal Beds." The paper described the system applied to pillars left by the earlier miners in the Mammoth bed which varied in thickness from 60 to 110 feet. The system is an innovation in anthracite mining, and has proved so satisfactory in recovering pillars that it is to be tried in mining the Mammoth bed. To reach the coal a series of chutes are driven in the Skidmore bed. At a given height cross-cuts are driven to the Mammoth bed, and then long parallel chutes are driven in the pillar at an angle of about 35 degrees to the strike. From these chutes at regular intervals, chutes are driven parallel with and up the pitch at right angles to the strike. The pillars thus cut in sections are worked from the top down the slope, as geologists would say in "echelon," but what miners call steps. All coal is carried to chutes driven in the Skidmore bed and loaded into cars on the Skidmore levels.

The meeting was of great importance to "Big-bed miners," therefore mine superintendents from the vari-

ous mines and companies in the Big-bed section who were not members of the Institute were invited guests. President Richards, of the Philadelphia & Reading Coal and Iron Co., presided. He opened the exercises by requesting those present to eat. They did. After coffee he requested them to stop eating and listen to Mr. Whildin. They did, but kept on smoking. The audience was so embarassed by the checker-board chutes displayed that they were inclined to believe that Mr. Whildin needed looking over, so it devolved upon Mr. Richards to start the questioning, and in a few minutes inquiries came fast. If permission is granted by the Council of the American Institute of Mining Engineers, The Colliery Engineer will print Mr. Whildin's paper, and comment on it.

PERSONALS

O. J. Patzold has been appointed sales manager for the La Follette Coal, Iron and Railway Co., by George M. Shoemaker, manager of operations under Neil Robinson, receiver for the above named company. Mr. Patzold's office will be at La Follette mines in Tennessee.

H. S. Gay, president of the Gay Coal and Coke Co., of Logan, W. Va., has sailed for London, Eng., where he has been invited to appear before the Royal Society of Engineers to read a paper demonstrating some newly discovered mathematical facts concerning angles and their degrees.

Richard Ghent, of Harrisburg, Ill., has been named general superintendent of the O'Gara Coal Co.'s mines, succeeding Harry Thomas, deceased. Mr. Ghent formerly was one of the assistant superintendents of the organization.

The Scranton Coal Co., at Scranton, Pa., announces the appointment of Daniel G. Young, district superintendent, as general superintendent of all the company's operations. He succeeds W. L. Allen, who was recently appointed general manager. Mr. Young was district superintendent for a number of years, succeeding the late John Von Bergen. Previously he was mine foreman at the Pine Brook, Mt. Pleasant, and Richmond collieries.

J. D. Cain, of Pineville, Ky., has been appointed Assistant State Inspector of Mines for a four-year term. He succeeds Perry V. Cole.

John O'Connor, of the Rochester and Pittsburg Coal Co., has accepted the position of auditor and assistant treasurer of the Brush Creek Coal Co., at Aultman, Pa.

A. W. Hesse, assistant chief engineer of the Consolidation Coal Co., at Fairmont, W. Va., has been appointed manager of the Lincoln Coal Corporation at Big Creek, W. Va.

J. B. Forrester, of Salt Lake City, has been appointed superintendent for the Panther Coal Co., at Carbon, Utah.

H. H. Sanderson, formerly of Colorado, is now superintendent of the Hiawatha mine of the Consolidated Fuel Co., at Hiawatha, Utah.

The Castle Valley Coal Co., of Utah, at its annual meeting at Evanston, Wyo., reelected its old board of directors as follows: J. H. Mays, president; E. L. Carpenter, first vice-president; Moroni Heiner, second vice-president; J. E. Forrester, secretary and treasurer.

F. H. Emerson has been appointed Boston District Manager of the Bristol Co., with headquarters in the Old South Building.

W. J. Walters, inside foreman at the Hollenback No. 2 colliery of the Lehigh & Wilkes-Barre Coal Co., at Wilkes-Barre, recently tendered his resignation after serving the company for over 47 years.

John Berkheiser, district superintendent of the Scranton Coal Co., at Scranton, Pa., for many years, has resigned. James W. Smith has been appointed as his successor. Mr. Berkheiser will continue to serve the company in an advisory capacity.

W. J. Richards, president of the Philadelphia & Reading Coal and Iron Co., in a circular letter under date of July 28 announced the following promotions of officials of that company: Michael J. Doyle, division engineer of the Tremont Division, is promoted to the position of division superintendent of the same divison. Ephraim J. Weimer, division engineer of the Minersville Division, is promoted to the position of division superintendent of the same division. Claude J. Lewis, division engineer of the St. Clair Division, is promoted to the position of division superintendent of the same division. Leslie D. Lamont, transitman, St. Clair Division, is promoted to the position of division engineer of the same division. Louis Lorenz, inside foreman, at Glendower colliery, is promoted to the position of assistant inside superintendent of the Shenandoah District. All of the promoted officials have been in the service of the Philadelphia & Reading Coal and Iron Co. since early manhood, and have won advancement through constant application and efficiency in the various subordinate positions they each filled.

Cause of Hillcrest Explosion

The finding of the jury in the Hillcrest mine explosion, which occurred June 19, 1914, in Alberta, Canada, and caused the death of 189 men, was that the disaster was caused by an explosion of gas and coal dust. The inquest lasted from June 20 to July 21.

The jury added that they did not think the regulations of the Coal Mines Act have been strictly adhered to and recommended that the Government enforce an inspection at intervals of not less than once a month for matches and pipes of all men employed in the mine. The jury further recommended that each company keep on hand as near the mine mouth as possible safety apparatus for use in case of accident.

Owing to Government investigations, it has been impossible to supply readers with an authentic account of this explosion; however, The Colliery Engineer will, when reliable information is released, give an account of the accident.

NEW MINING MACHINERY

Aldrich Slush Pump

The Aldrich Pump Co., of Allentown, Pa., have supplied a 14″ × 16″ triplex pump to the Lehigh Coal and Navigation Co., designed to pump 1,000 gallons per minute against a head of 100 feet at 3.2 revolutions per minute. Slush is composed of fine coal, slate, sandstone, pyrite, and water, which makes a fluid mixture having a consistency that varies from oyster stew, through pea soup to custard pie, and any of these grades may be delivered to the pump without warning. In this particular case the slush averages 15 per cent. solids to 85 per cent. liquids, and to avoid abnormal wear on the water end the pump was designed to run at slow speed. The pump is electrically driven by means of a 50-horsepower, 440-volt, 25-cycle, three-phase motor, the power being transmitted from the motor on a base plate above the working barrels to the pump plungers by means of herring-bone gears.

The pump is equipped with bronze plungers, bronze lined stuffingbox glands, and the entire water end of the pump lined with imported cement. The valves of this pump are of the ball type, being made of solid bronze.

The pump has given exceptionaly good service, up to this time none of the valves has been changed, nor has it been necessary to reline the water end with cement.

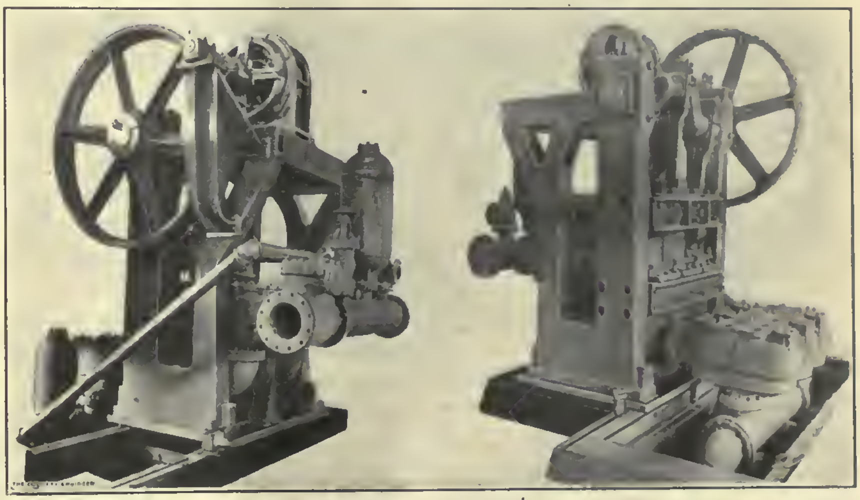


Fig. 1. The Aldrich Slush Pump

Electric Mine Pump for High Head

The accompanying illustration shows an electric motor and mine pump of the El Oro Mining and Railway Co., of El Oro, Mexico, installed and said to be one of the largest motor-driven pump equipments built for unwatering a mine.

The pump, shown in Fig. 2, is 6 in. × 20 in. Goulds design with a capacity of 500 gallons per minute. The construction is such that the pump was readily dismantled and lowered down the shaft and when assembled it requires very little head room.

The pump is installed on the bottom level and pumps against a head of 1,300 feet. The 300-horsepower driving motor is supplied with a three-phase alternating current at 440 volts, and operates at a speed of 485 revolutions per minute.

A Westinghouse motor is connected to the pump with a double reduction gearing giving the pump crank-shaft a speed of 35 revolutions per minute and affording an excellent illustration of the advantages of the electric driven pump in mine service.—*F. C. P.*

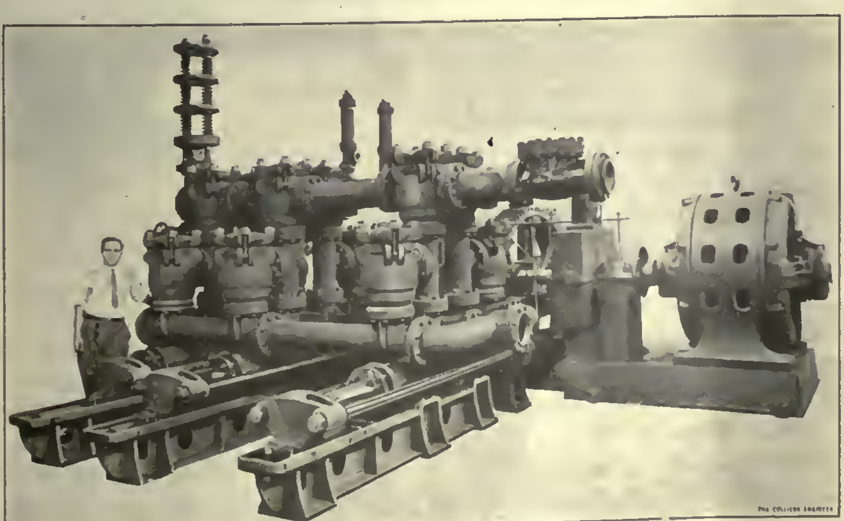


Fig. 2. Goulds Electric Mine Pump

Robinson Turbine Fan

The Robinson Ventilating Co., successors to J. R. Robinson, of Pittsburg, have developed the ven-

tilator shown in Fig. 3, which is termed a "turbine fan." The blades are curved, so that the air taken in axially is given a spiral motion before it attains the right angle necessary for the discharge. It will be noted that the fan is divided in the center so as to take air on each side; further, that it has no spider arms to baffle the air as it goes to the blades.

Fig. 3. Robinson Turbine Fan

The ventilation of mines has been a hit and miss proposition for many years. Certain sizes of fans have been demanded from fan manufacturers by mine owners, without regard to the conditions of the mines for which the fans were intended, and the consequences have been disastrous to the ventilation.

It is an engineering problem to properly ventilate a mine, as each mine generally presents problems that should be solved and suitable fans applied to meet the conditions of the mine. This is much more reasonable and scientific than making the air-courses over to suit the fan.

Starting Unloader for Motor-Driven Compressors

To maintain a uniform pressure in the receiver and pipe lines and to prevent the engine or motor driving the air compressor from stalling through overload, it is essential that the compressor, whether steam, gas, or motor driven, be provided with some device that will unload it, when the desired receiver pressure is attained, and start the air into the receiver again when the pressure has fallen but a small amount below maximum, or any predetermined point.

A highly perfected starting unloader for motor-driven compressors, in which the motor current is cut out or in to stop or start the compressor when a maximum or minimum load is reached, has recently been added to the field of air controlling devices and is shown in Fig. 4.

The unloading action is obtained by the velocity of the air pressure passing through the chamber, and the variation of the receiver pressure.

The compressor is completely unloaded when speed is reduced about 25 per cent. and by this action any recoil on the last revolution experienced when stopping against a load is obviated.

When the motor starts the air is by-passed to the atmosphere until the desired speed is obtained, at which point the by-pass valve closes and the air passes to the receiver until the predetermined pressure at which current is cut out is reached. Then the by-pass is opened by the receiver pressure, via the trigger, against the unloading piston. The intake air has then, with the compressor loaded, a practically free passage through the cylinder, with resultant cooling effect until the machine stops.

The different loading and unloading operations are dependent upon the speed of the machine and therefore entirely automatic.

When the current is cut out and the compressor slows down, the bypass valve opens automatically and unloads before the compressor stops. When the current is cut in, compression does not occur until the motor has obtained the desired speed.

The advantage of this new unloader is in the fact that a compressor equipped with it will require less power to start it. Such a compressor can therefore be driven by a motor of much less power than ordinarily used.

The operating parts of this device are simple and consist of a by-pass valve, a check-valve, unloading piston, and trigger.

The unloader is generally placed on the discharge port of the compressor cylinder, but may be placed anywhere in the discharge line near the cylinder and efficient operation will not be hindered.

The unloader in no way controls the starting and stopping of the motor, it merely unloads the compressor and keeps it unloaded until it is again started and up to required speed. The control of the motor current is accomplished by some one of the standard controlling switches and circuit-breakers.

Metallic Tape "Threader"

The Lufkin Rule Co., of Saginaw, Mich., have put out a patented measuring tape attachment known as a "threader" which will hereafter be furnished with their "Metallic" woven tapes without extra charge.

The "threader" is a loop-and-stud arrangement, by means of which the tape, though securely fastened to the winding drum of the case when in use, can yet be readily detached from it and a new tape as readily

Fig. 4. Unloader for Compressor

attached, no manipulation of the case screw or drum being required to do this.

Woven tapes are sometimes torn by accident or through long use often become soiled and worn in such a way that they must be replaced while the case is yet in very fair condition. The case not receiving the same hard use as the tape

line usually outwears it, and representing approximately half the value of the outfit it is of considerable importance that it be a simple matter for any one to insert a new tape in the old case as often as necessary and thus get the fullest measure of use out of the case as well as the tape. Metallic tapes without cases are quite generally stocked by hardware houses, etc., and can always be easily obtained. The attaching is perfectly and easily accomplished by means of the "threader."

Blackwood Colliery Gasoline Hoist

By L. F. Mitten

The Blackwood colliery of the Lehigh Valley Coal Co. is in an isolated section where there is no power of any sort, so it was decided to install a gasoline hoisting engine. After going carefully into the cost of installing a water plant and steam hoist, or of running a transmission line from the nearest source of electrical supply and operating the hoist electrically, comparison of the relative costs were so far in favor of the gasoline hoist that there was no hesitancy in deciding on its installation, and the contract for its construction was given the Vulcan Iron Works, of Wilkes-Barre, Pa.

Single-car trips are handled on the slope, the car and coal weighing approximately 4,000 pounds. The slope, which is about 500 feet long, has an inclination of 40 degrees from the horizontal, hence the load requires 2,571.2 pounds to balance it. The cars are handled at a rope speed of 200 feet per minute. As shown in Fig. 5 the entire outfit is arranged to be readily transported from one place to another, if occasion demands. The drum is loose on the shaft, is driven by band friction clutch, and is controlled by the usual band brakes operated by hand.

The driving engine, which has four 5″ × 6″ cylinders, is equipped with governor, magneto, battery, intake and overflow water pipes, water circulating pump, and intake and exhaust manifold.

Owing to the hoisting conditions, it is necessary to reverse the direction of the drum, and therefore it was necessary to equip the hoist with reversing gears. Hoists of this type have been used for a number of years at small gold and silver mines, where if steam power was used there would necessarily be an installation of boilers which would be very expensive in certain places both to install and keep in operation. In comparing the first cost of steam or electrically driven hoists with the gasoline hoist, the comparison will be in favor of gasoline hoist. Whenever the outfit is to be located a considerable distance from the source of power supply the cost of operation and upkeep would run somewhat higher than that of an electric hoist, the consumption being approximately 1 gallon of gasoline per horsepower per hour when operating at full load.

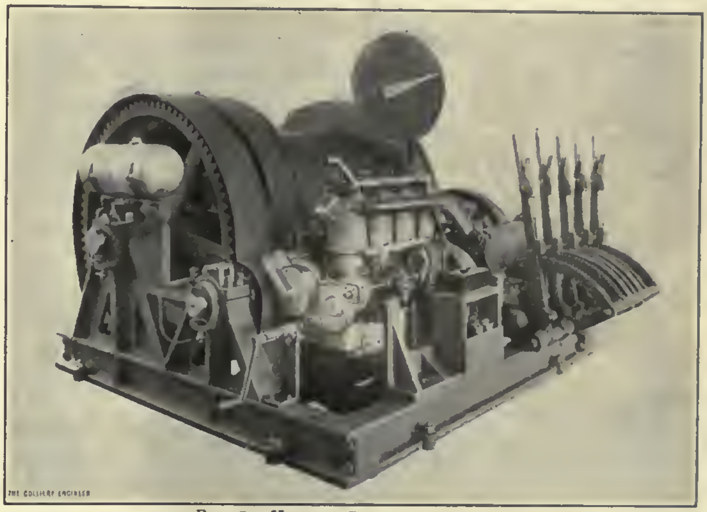


Fig. 5. Vulcan Gasoline Hoist

TRADE NOTICES

Asbestos Roofing.—The efficiency of asbestos roofing as a fire stop is illustrated by the fact that, in the Salem, Mass., fire, sparks and burning embers were literally showered upon the roof of the Naumkeag Steam Cotton Co.'s storehouse, yet this building was absolutely unharmed because protected by J-M asbestos roofing, while other buildings all around it were burned to the ground.

The Bristol Co.—This year is the twenty-fifth anniversary of the founding of The Bristol Co. plant. This recording instrument company has doubled its floor space every 5 years during the last 25 years The growth of this business has been especially large since 1908, when President William H. Bristol again took up the general management of this company. To date, over 65,000 Bristol recorders have been sold.

Gas Analysis Apparatus.—It is announced by H. N. Elmer, North American agent for Siebe, Gorman & Co., Ltd., that Eimer & Amend, of New York City, have been appointed eastern agents for the sale of gas analysis apparatus which Siebe, Gorman & Co. manufacture in accordance with Doctor Haldane's personal instructions.

Fairbanks-Morse Co. are constructing a new tipple for the Bailie-Wood Co., Wood Bay, W. Va.

The Link-Belt Co., of Philadelphia, has been awarded the contract for a complete shaking screen tipple outfit by the Warrior Coal and Coke Co., of War, W. Va. The plant will consist of a hopper at the drift mouth, into which the coal will be dumped from the mine cars, and from which it will be fed by a feeder to a long apron conveyer, which makes delivery to the shaking screen tipple at

the foot of the hill. Here it will be sized and loaded to the cars by means of a loading boom.

The George D. Whitcomb Co., of Rochelle, Ill., has taken over the business of the C. R. Davis Mfg. Co., of Detroit, Mich., covering electric storage battery motors, and will manufacture them in connection with the Whitcomb gasoline mine locomotives. The storage battery locomotive was developed for thin bedded coal, and its height is about 30 inches above the rail. Their use has in a number of cases done away with lifting the bottom and brushing the top to get head room. One motor has gathered from 150 to 175 cars of coal a day, going to the room face to get the loaded cars, but leaving the empty cars at the room neck. The company expects to develop a system whereby heavy gasoline locomotives on main haulage can be supplemented by lighter storage battery locomotives on cross-headings.

The Sullivan Machinery Co. announce the establishment of a new office in Juneau, Alaska. Burt B. Brewster, formerly at the St. Louis office of the company, will be the manager, and a stock of rock drills, hammer drills, spare parts, supplies, etc., will be kept on hand.

General Electric Co.—Electrical apparatus for coal mines has recently been ordered from the General Electric Co. as follows:

The Davis Coal and Coke Co., Baltimore, Md., induction motors with starting compensators, one 200 horsepower, three 150 horsepower, and four 100 horsepower capacity; the Bailey-Wood Coal Co., McAlpin, W. Va., for its mine at Wood Bay, W. Va., a 220-kilowat, direct-current generator; the American Coal Mining Co., Bicknell, Ind., one 20 horsepower, and two 5 horsepower induction motors for its electric drive equipment; the Fluhart Collieries Co., Whitehouse, Ky., a 150-kilowatt motor-generator set; the Consolidation Coal Co., Fairmont, W. Va., a 1,280 kv-a. alternating-current generator with starting panel; the Stillwater Coal Mining Co., Tippecanoe, Ohio, a 150-kilowatt alternating-current generator with 5-kilowatt exciter, a 75-horsepower induction motor, switchboard, and accessories.

Roberts & Schaefer Co.—In addition to the mining plant recently ordered for Hurricane, W. Va., the Clinchfield Coal Corporation has awarded to Roberts & Schaefer Co. a contract for a Marcus coal tipple installation at Dante, W. Va., price approximately $55,000. The latter company also has sold the following: North Fork Coal Co., of Cleveland, Ohio, a Marcus picking table screen, price $7,000; the Chicago and Carterville Coal Co., Herrin, Ill., complete coal mining plant to replace the one recently destroyed by fire, price $20,000; Brothers Valley Coal Co., Macdonaldton, Pa., a Marcus patent coal tipple.

Catalogs Received

Hardsocg Wonder Drill Co., Ottumwa, Iowa. Bulletin No. 50, Automatic Bit Rotating, Stopping, Drifting, and Sinking Drills; No. 51, Pneumatic Rock Drills for all purposes; No. 52, Rock Drill Bits, Drilled Hollow Steel, Hose, and Hose Couplers, Hose Clamp Tool, Bit Sharpening Tools, etc.; No. 53, Stoping, Drifting, and Reciprocating Drills; No. 54, Self-Rotating Plug Drill No. 65.

Allis-Chalmers Mfg Co., Milwaukee, Wis. Bulletin No. 1085, Kerosene Engine Generating Sets, 12 pages; No. 1087, Polyphase Induction Motors, 20 pages.

The Lunkenheimer Co., Cincinnati, Ohio. Grinding, 16 pages.

Newton Machine Tool Works, 23d and Vine Streets, Philadelphia, Pa. Catalog No. 48, Newton Machine Tools, 48 pages.

The Esterline Co., Indianapolis, Ind. Esterline Graphic Efficiency Instruments, Model E B Meters, 40 pages.

The Hess-Bright Mfg. Co., Philadelphia, Pa. Ball Bearings in Machine Tools, 32 pages.

National Tube Co., Pittsburg, Pa. Bulletin No. 13A, N. T. C. Iron Body Brass Mounted Wedge Gate Valves, 12 pages.

Geo. D. Whitcomb Co., Chicago, Ill. Mechanical Methods of Mining, 100 pages.

Fort Wayne Electric Works, Fort Wayne, Ind. Fort Wayne Electric Rock Drill, Type "A," 20 pages.

Western Electric Co., New York, N. Y. Modern Methods in Train Dispatching, 18 pages.

Development Notes

The Illinois Pipe and Mfg. Co., of Chicago, Ill., has purchased the entire plant of the Cardiff Coal Co., of Cardiff, Ill., structural steel buildings and mine equipment, and offer it for sale in part or in whole.

The Charleroi Gas Coal Co., of Pittsburg, will open a new mine on Maple Creek, Fallowfield Township, Washington County, Pa.

The Euclid Coal Co. will open a coal mine on a 1,000-acre tract of land at Euclid Station, Pa.

It is stated that 200 acres of coal land at Central City, Pa., will be developed by the Bougher-Chrichton-Evans interests.

Enterprising citizens of Marissa, Ill., propose to prospect for coal, and form a local mining company in case coal be found.

If the contemplated reorganization of the Seneca Coal Mining Co., of Buffalo, is successful, a new mine will be opened in place of the Punxsutawney company's mine that was relinquished.

The Wasson Coal Co., of Harrisburg, Ill., is driving a new slope at its mines in Southern Illinois.

The Middle Fork Mining Co., of Benton, Ill., is sinking a shaft upon new operations in that section. Power will be purchased from a central station.

The washery of the Lackawanna Coal and Coke Co., at Wehrum, Pa., was destroyed by fire August 7, entailing a loss of several thousand dollars and throwing 300 men idle temporarily.

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The Colliery Engineer
Formerly Mines and Minerals

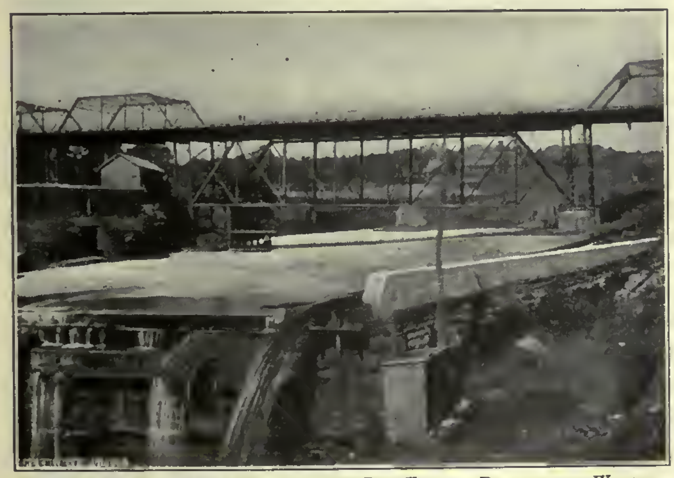
Vol. XXXV—No. 3 OCTOBER, 1914 Scranton, Pa.

Dredging Anthracite

The Discovery of a Coal Deposit in a Near-By Stream Leads to a Dredging Installation to Supply a Large Power Station With Fuel

By F. W. Brady, M. E.

As the price of anthracite to the general consumer is rising, it is almost unbelievable that a company should discover a way to get coal free of mining costs. The credit of making this discovery and the ingenuity in perfecting a system for delivering the coal into the storage yard and bunkers of the power station belongs to George Esslinger, chief engineer of the L. & W. V. Ry., locally known as the "Laurel Line," of Scranton, Pa. It is to the forces of Nature, however, that the ultimate credit is due for conserving in a peculiar manner a bounteous coal supply.



Dam That Catches the Coal. Note Box Trough Discharging Waste Water From Car Loader

Coal Dredge With Its Long Floating Discharge Pipe Delivering to Booster Pump on Shore

Roaring Brook is a dashing mountain stream leading from the Poconos to the Lackawanna River. It drains a mining district of moderate size and parallels two of the railroads that carry the coal to the eastern markets, and then the stream incidentally flows close by the power station of the Laurel Line and through its terminal switching yards that occupy several acres. The water from the brook serves for condenser purposes, and the water held by a stone dam located just below the power station forms a cooling pond and a return circulation during the low-water season. This dam is an inheritance from a steel company that formerly occupied the site.

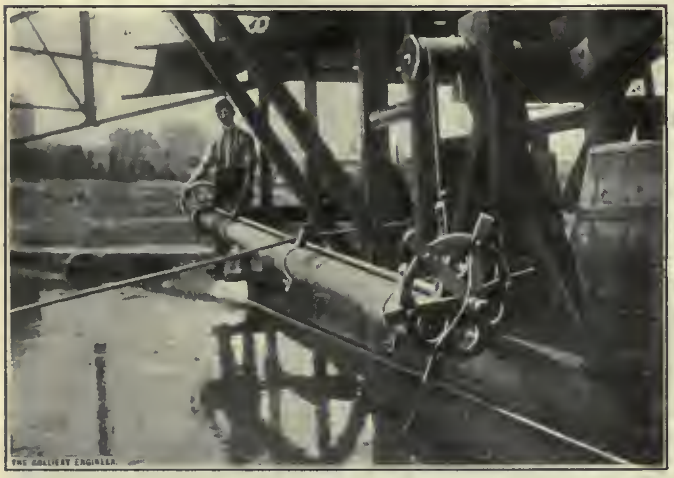
It was when cleaning out the pond some 3 years ago by means of the gates in the dam provided for the purpose that the engineer got a peep at the coal impounded. The dam was literally filled to overflowing with good coal. It had in fact been filled for years and probably several thousand tons of coal have overflowed, but the value of its contents had never before been suspected, much less had any practical system of getting out the coal been dreamed of.

Anthracite will move readily in flowing water, but it will settle in slack water, such as that above a dam. Roaring Brook carries a heavy burden of anthracite during every freshet, and after dredging this pond last season, it was observed that in two days during a freshet more coal had been brought in than had been taken out. The supply, therefore, seems likely to be continuous for some time. The source of the coal is the many culm piles, operating breakers, and washeries above the dam. Also there is a continual loss of coal from the thousands of loaded cars that pass along the banks of the stream on their way to market.

The Coal Recovery Plant.—The coal recovery plant consists of a scow with dredging machinery, a floating pipe line, a booster pumping station on shore, a screen shaker and coal loader, and a waste dis-

posal. The plant is an experimental one developed during the season of 1913, and constructed of second-hand machinery. The recovery last year was over 30,000 tons of coal at the low labor cost of about 14 cents per ton. The plant as perfected at present will handle better than 100 tons per day, and the average for the entire season will exceed 50 tons per day.

The "business end" of the system consists of a float, 9 ft. × 18 ft., which carries a 35-horsepower, 500-volt, direct-current motor belted to a 6-inch Morris centrifugal pump capable of passing 4-inch solids. Swinging wires furnish the current from the street-car tracks where they cross just above the pond. The intake of the pump is a 14-foot length of 6-inch spiral riveted pipe attached to the pump by means of a swivel joint. A windlass with a half-inch rope controls the outer end of the suction pipe which may be lowered 12 feet or brought to the surface as required.



Agitator on Dredge

Booster Pumping Installation to Transmit Coal to Cleaner

One of the most important features of the dredge is the agitator located on the end of the suction pipe. Considerable experimenting was necessary in order to develop an agitator that would keep the pipe clear of debris, stir up the coal and allow free suction. The agitator used at present is operated by hand, though it could be arranged for power. It consists of a boiler-plate disk 18 inches in diameter, pierced with six 4-inch holes near its periphery. Three straps of steel are riveted across the face of the disk and extend about 3 inches beyond its edge. These six ends form the cutters for loosening up the coal under the water. The agitator is mounted on a shaft extending the full length of the suction pipe and supported in bearings attached to the top of the pipe. This method locates the agitator close up against the end of the pipe, and as the agitator is revolved constantly its eccentric mounting carries some of the debris away from the area of strongest suction. The hand wheel is of the type commonly used as a brake wheel on cars. Two operators are required on the float, one at the agitator wheel and one at the windlass. The centrifugal pump lifts a flood of water carrying about one-tenth solids and delivers it through a floating pipe line of 6-inch spiral riveted pipe to the shore centrifugal pump in series with it. The floats are made of barrels arranged in pairs with the pipe lying between them. Two strips of 2″ × 6″ pine with a half-inch rod bolt at each end form a clamp for holding the barrels together and a support for the pipe. A swivel joint at the shore end permits the floating pipe to swing freely over the pond.

Stock Pile and Conveyer System at Power House

The shore motor of 50 horsepower is belted to a 6-inch Morris centrifugal pump using a Gandy belt the same as that on the float. The motor, pump, and accessories are set against and sheltered by the pier of the highway bridge over the pond. From the booster pump the stream is driven about 100 feet and to an elevation of 25 feet to the top of the motor-operated box shaker, screen, and the loader. The screen is of sixteenth-inch mesh and removes the sand and water from the coal, and the cleaned coal is delivered into the car. The water with its load of dirt returns by gravity through an open box trough to the spillway below the dam. Two men are required to look after the booster motor and the loader, making four men in all for the plant. The operation is for 6 days per week, and the plant is closed down in midwinter when ice bound.

It is necessary to prime a centrifugal pump on starting. The pump on the float is stopped frequently in order to change the location of the float or to clean the agitator. The priming is made easy by the use of a 1-horsepower pump. The priming of the booster pump is automatic, and this pump also aids in priming the pump on the float.

One gratifying feature in the operation of this plant has been the absence of breakdowns. There were none at all the first year. Only one has occurred this year, and this one caused a delay of 2 hours, and was due to a hole wearing in the pump casing.

Quality of the Coal.—The grade of the coal, known locally as "river coal," is that called No. 2 barley—at least 75 per cent. of it is of this grade. Its heating value averages about 11,000 B. T. U., while the fresh mined barley furnished by the collieries of the Pennsylvania Coal Co. runs about 12,500 B. T. U.

The average evaporation per pound of the river coal is 5.48 pounds of water, while that of the fresh mined barley is 7.35 pounds. The fineness test made on dry coal is as follows:

Fifty per cent. passes through a 1/16-inch screen; 25 per cent. passes through 3/32-inch screen; 12½ per cent. passes through 9/64-inch screen; 7.5 per cent. passes through 7/32-inch screen; 5 per cent. is coarser than these screens.

Considerable ash is reclaimed with the coal, so that the furnace ash sometimes runs as high as 30 per cent.

The coal is handled at the power station by means of an elaborate and specially ingenious conveyer system which has a capacity of 300 tons per 24 hours, and requires only one man to look after it. The car dumps through the bottom into a track pit. A spiral conveyer with its screw set at right angles to the track moves the coal over to the conveyer tower. Here an arrangement of chutes diverts the stream as desired either to the scraper conveyer delivering to the open storage piles or to the scraper conveyer delivering through a long incline to the bunkers over the boiler furnaces. The coal passes from the bunkers through vertical chutes having hand-operated gates on to tables before the furnace doors, and is hand fired.

Cleaner and Car Loader on Switch

One Source of River Coal—Train Wreck on Railroad

Driving Rooms on Line

The difficulty some mine foremen have in getting rooms driven on line is most often due to the fact that the line plugs set in the roof are too close together. If the line plugs are set 8, 10, or 12 feet apart (a greater distance when possible is still better) there should be no trouble in driving a room 200 or 300 yards on accurate lines.

If the two line plugs are 8 feet or more apart, and nails, or spads are accurately set in them, new line plugs can be set as near the face as desired by hanging weighted lines from the two original plugs, and then the foreman, standing back of the first weighted line, having a man hold a lamp back of the second line, to illuminate it, can by closing one eye direct a second man where to drill holes for third and fourth plugs exactly in line with the two weighted lines from the original plugs. After the new plugs are inserted in the holes, nails or spads can by the same operation be driven in them exactly in line.

The writer has, on many occasions, extended lines set by the surveyors in this manner and invariably kept the room or passageway exactly on line.

In one case an airway several hundred yards long was to be driven on line to meet an air-shaft already sunk.

The airway was in coal and the seam changed in pitch several times. The surveyors set the original plugs about 10 feet apart, with a transit.

As the airway progressed, changes in the pitch made it impossible to use the original lines. New plugs were set by the method described above as often as necessary, and as was to be expected the air-course struck the bottom of the shaft as accurately as would have been the case had the new lines been set by a transit.

Daylight Furnaces

For Mine Ventilation—Calculating Dimensions—Effect of Location of Furnace With Respect to Inlet

*By Frank E. Brackett**

CENTRIFUGAL fans (either exhaust or blowing) have pretty generally superseded the mine furnace for ventilation; and very properly, as they are much more powerful and efficient; but in locations where sweet water is expensive and difficult to get, and in remote regions where skilled labor is costly, or perhaps unobtainable, and also where repair shops are far away, for mines of moderate water gauge, with no firedamp, and a cropping seam, there is yet demand for this simple structure, so cheaply run, and so reliable. These furnaces are not located in the coal seam, but built outside in the daylight, and connected with the return airway by stone, brick, or concrete passages, in such a way as to obviate all danger from fire.

It may interest your numerous readers, whose attention has been called to this subject, to note the following method of calculating the dimensions of the furnace for rise and dip workings that crop, and the effect which the location of the furnace, with respect to the inlet, has upon its efficiency, and its safety, especially as there is much incredulity as to the possibility of any such thing being feasible or practicable. The writer does not recall ever having met with any attempt to elucidate the subject.

Let the accompanying Fig. 1 represent a portion of a mine with the coal seam cropping as shown, and from which a daily output of 1,000 tons of coal is required, and at which it is desired to erect a "daylight furnace" for the necessary ventilation. Let 30,000 cubic feet of air per minute be allowed as sufficient for men, horses, lights, gas, and rotten timbers, etc., and leaks (for we all know wooden brattices will leak, the rats attend to that).

It is a very difficult problem to calculate what the water gauge of a proposed mine will be; such a calculation should be compared with actual results (obtained by experiments) in mines of the same or similar localities, and of practically the same size. Better assume too large a water gauge than too small.

Let us assume the total available head (T. A. H.) necessary to circulate 30,000 cubic feet of air per minute through the mine to be 1.86 pounds per square foot, of which the stack

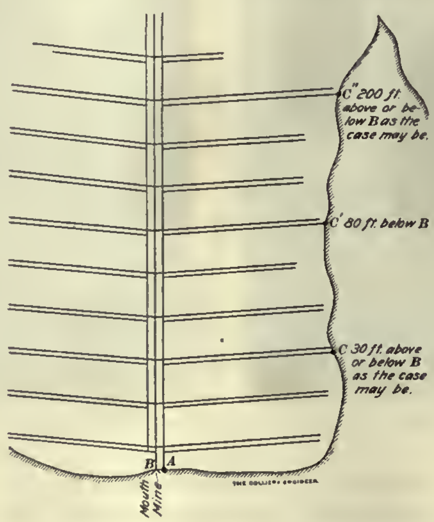


Fig. 1

(or furnace) resistance takes $\frac{1}{3}$ and the mine drag $\frac{2}{3}$, thus, stack resistance = .62 pound; mine drag = 1.24 pounds. Total available head = 1.86 pounds per square foot.

Assumed Temperatures	Temperature Degrees F.	Weight Per Cubic Foot Pound
Winter-day atmosphere......	0	.0864
Winter-night atmosphere ...	0	.0864
Winter average mine air....	48	.0782
Winter mine air at furnace..	56	.0770
Summer-day atmosphere....	82	.0733
Summer-night atmosphere ..	72	.0747
Summer average mine air...	58	.0767
Summer mine air at furnace.	66	.0755
Day temperature of hot gas in stack..................	325	.0506
Night temperature of hot gas in stack..................	112	.0694

All corrections due to humidity and pressure are neglected as unnecessary, and the above are weights of dry air as given in "Box's Treatise on Heat." The temperatures may be altered to suit any locality or mine.

Case First.—Assume the location of the proposed furnace at A, Fig. 1, practically on the same level as the mine mouth or inlet B. What must be the height of the stack above the flame bridge to give the necessary T. A. H. = 1.86 pounds?

The furnace and the inlet being practically on the same level, the question of rise or dip workings need not be considered.

In summer (H being the stack height):

$$\text{T. A. H.} = H \times \text{wt. cu. ft. atmos. @ } 82^\circ - H \times \text{wt. cu. ft. gas @ } 325^\circ;$$
$$= H \times .0733 - H \times .0506$$
$$= H \times (.0733 - .0506)$$
$$= H \times .0227 = 1.86;$$
$$H = \frac{1.86}{.0227} = 82 \text{ ft. high.}$$

In winter (with this 82-foot stack):

$$\text{T. A. H.} = 82 \text{ ft.} \times \text{wt. cu. ft. atmos. @ } 0^\circ - 82 \text{ ft.} \times \text{wt. cu. ft. hot gas @ } 325^\circ;$$
$$= 82 \times .0864 - 82 \times .0506$$
$$= 82\ (.0864 - .0506)$$
$$= 82 \times .0358 = 2.94 \text{ lb. per sq. ft.}$$

Winter favors the ventilation. Will this mine furnace draw down, and reverse the ventilation during the night, filling the mine with smoke, delaying the work in the morning, and perhaps setting the place on fire, unless the same has been properly built? Many serious fires have happened from the neglect of the consideration of this question.

The writer's experience has been that the stacks cool down through the night to about 112°.

As the total available head is less in summer, the furnace should be tested for this season.

The summer minimum T. A. H. at night:

$$\text{T. A. H.} = 82 \text{ ft.} \times \text{wt. cu. ft. atmos. @ } 72^\circ - 82 \text{ ft.} \times \text{wt. cu. ft. hot gas @ } 112^\circ;$$
$$= 82\ (.0747 - .0694) = 82 \times (.0053) = .43 \text{ lb. per sq. ft.}$$

Case Second.—Assume the location of the proposed furnace at C, Fig. 1, with the top of the flame bridge 30 feet above the inlet B, with rise workings. What must be the height

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of the stack above the flame bridge to give the necessary T. A. H.?

In summer:

T. A. H. = (H + 30) × wt. cu. ft. atmos. @ 82° − 30 ft. × wt. cu. ft. mine air − H × wt. hot gas @ 325°;
= H (.0733 − .0506) + 30 (.0733 − .0767) = 1.86.

$$H = \frac{1.86 + .1020}{.0227} = 86 \text{ ft. high.}$$

In winter (with this 86-foot stack):

T. A. H. = 116 ft. atmos. @ 0° − 30 ft. mine air @ 48° − 86 ft. hot gas @ 325°;
= 116 × .0864 − 30 × .0782 − 86 × .0506 = 3.32 lb. per sq. ft.

Winter favors the ventilation.

Will this furnace draw down and reverse the ventilation at night?

The summer minimum T. A. H. at night:

T. A. H. = 116 ft. atmos. @ 72° − 30 ft. mine air @ 58° − 86 ft. hot gas @ 112°;
= 116 × .0747 − 30 × .0767 − 86 × .0694 = .40 lb. per sq. ft.

Case Third.—Assume the above mine furnace to have been located at a point C'', Fig. 1, 200 feet above the inlet B, rise workings.

In summer:

T. A. H. = 286 ft. atmos. 82° − 200 ft. mine air @ 58° − 86 ft. hot gas @ 325°;
= 286 × .0733 − 200 × .0767 − 86 × .0506 = 1.27 lb. per sq. ft.

In winter:

T. A. H. = 286 ft. atmos. @ 0° − 200 ft. mine air @ 48° − 86 ft. hot gas @ 325°;
= 286 × .0864 − 200 × .0782 − 86 × .0506;
= 24.71 − 15.64 − 4.32 = 4.72 lb. per sq. ft.

Winter favors the ventilation.

The result of the summer calculation shows this furnace, in this location would be a failure, for 1.86 T. A. H. is needed, and we have only 1.27 pounds.

Case Fourth.—Suppose this mine furnace to be located at C, Fig. 1, with its flame bridge 30 feet below the inlet B and dip workings. What would be the necessary height of stack to give the required ventilation?

In summer:

T. A. H. = (H − 30) ft. atmos. @ 82° + 30 ft. mine air @ 58° − H ft. hot gas @ 325°;
1.86 = H × .0733 − 30 × .0733 + 30 × .0767 − H × .0506;
1.86 = H (.0733 − .0506) + 30 (.0767 − .0733) = H (.0227) + 30 (.0034) = H (.0227) + .102;

$$H = \frac{1.86 - .1020}{.0227} = 80 \text{ ft. high}$$

(say).

In winter (with this 80-foot stack):

T. A. H. = 50 ft. atmos. @ 0° + 30 ft. mine air @ 48° − 80 ft. hot gas @ 325°;
= 50 × .0864 + 30 × .0782 − 80 × .0506 = 2.62 lb. per sq. ft.

Winter favors this ventilation.

Will this furnace draw down, and reverse the ventilation at night?

The summer minimum T. A. H. at night:

T. A. H. = 50 ft. atmos. @ 72° + 30 ft. mine air @ 58° − 80 ft. hot gas @ 112°;
= 50 × .0747 + 30 × .0767 − 80 × .0694 = .49 lb. per sq. ft.

Case Fifth.—Suppose this mine furnace with its 80-foot stack to be located at C', Fig. 1, with its flame bridge 80 feet below the inlet B and dip workings. Would it give the necessary ventilation?

In summer:

T. A. H. = 80 ft. mine air @ 58° − 80 ft. hot gas @ 325°
= 80 × .0767 − 80 × .0506;
= 80 (.0767 − .0506) = 2.09 lb. per sq. ft.

In winter:

T. A. H. = 80 ft. mine air @ 48° − 80 ft. hot gas @ 325°
= 80 × .0276 = 2.21 lb. per sq. ft.

The summer and winter T. A. H. practically alike. The outside temperature does not appear. Good air all the year round. The stack in this location could be a little lower. Will this furnace draw down and reverse the ventilation at night?

The summer minimum T. A. H. at night:

T. A. H. = 80 ft. mine air @ 58° − 80 ft. hot gas @ 112° = 80 × .0767 − 80 × .0694;
= 80 × .0073 = 1.58 lb. per sq. ft.

Case Sixth.—Suppose this furnace with its 80-foot stack to be located at C'', Fig. 1, with its flame bridge 200 feet below the inlet B and dip workings. Would it give the necessary ventilation?

In summer:

T. A. H. = 200 ft. mine air @ 58 − 120 ft. atmos. @ 82° − 80 ft. hot gas @ 325;
= 200 × .0767 − 120 × .0733 − 80 × .0506 = 15.34 − 8.80 − 4.05;
= 15.34 − 12.85 = 2.49 lb. per sq. ft.

In winter:

T. A. H. = 200 ft. mine air @ 48° − 120 ft. atmos. @ 0° − 80 ft. hot gas @ 325°;
= 200 × .0782 − 120 × .0864 − 4.05 = 15.64 − 10.39 − 4.05 = 1.22 lb. per sq. ft.

Summer favors this ventilation.

The result of the winter calculation shows the furnace to be a failure in this location, for we have only 1.22 pounds per square foot for T. A. H.

From the foregoing it will readily appear that it is dangerous to locate a mine furnace at any point with regard to the inlet level, without careful attention to both summer and winter conditions.

It is advantageous to locate the mine furnace near the mine mouth or inlet, as being more convenient and accessible, making the plant more compact; it is also well situated for delivering coal to the furnace in mine cars if necessary and for taking out finally the main pillars.

For easy inspection the above results are condensed in Table 1.

The smallest T. A. H. at night was .40 pound per square foot. Later we will find that for the daylight furnace designed in this paper the ratio of the stack resistance to the T. A. H.

will be 29 per cent. instead of 33 per cent. assumed. 29 per cent. of .40 =.116 pound, which leaves .284 pound for the mine drag.

TABLE 1

30,000 cu. ft. air per minute—Necessary T. A. H. = 1.86 lb. per sq. ft.
Rise workings: Mine furnace on level with inlet—
Stack = 82 ft. high
T. A. H. = 1.86 lb. in summer
T. A. H. = 2.94 lb. in winter
T. A. H. = .43 lb. min. summer at night
Rise workings: Mine furnace 30 feet above inlet—
Stack = 86 ft. high
T. A. H. = 1.86 lb. in summer
T. A. H. = 3.32 lb. in winter
T. A. H. = .40 lb. min. summer at night
Rise workings: Mine furnace 200 feet above inlet—
Stack = 86 ft. high
T. A. H. = 1.27 lb. in summer
T. A. H. = 4.72 lb. in winter
A failure in summer.
Dip workings: Mine furnace 30 feet below inlet—
Stack = 80 ft. high
T. A. H. = 1.86 lb. in summer
T. A. H. = 2.62 lb. in winter
T. A. H. = .49 min. summer at night
Dip workings: Mine furnace 80 feet below inlet—
Stack = 80 ft. high
T. A. H. = 2.09 lb. in summer
T. A. H. = 2.21 lb. in winter
T. A. H. = .58 lb. min. summer at night
Dip workings: Mine furnace 200 feet below inlet—
Stack = 80 ft. high
T. A. H. = 2.49 lb. in summer
T. A. H. = 1.22 lb. in winter
A failure in winter.

What amount of air will circulate at night with T. A. H. = .40 pound?

$$30{,}000 : Q = \sqrt{1.24} : \sqrt{.284} = 1.1136 : .5330;$$

$$Q = \frac{30{,}000 \times .5330}{1.1136} = 14{,}360$$ cubic feet air per minute.

Evidently enough to keep the air from reversing.

We will consider further *Case First*, rise workings, where the mine furnace with an 82-foot stack is practically level with the inlet B, circulating 30,000 cubic feet per minute, with a T. A. H. = 1.86 pounds per square foot, $\frac{1}{3}$ to stack resistance and $\frac{2}{3}$ to mine drag.

The Amount of Coal Burned Per Hour.—"Useful Metals and Their Alloys" state that the average effect of 1 pound of coal is to heat 500,000 cubic feet of air 1° F. (from experiments at the famous Hetton colliery in Great Britain), which seems to have been generally accepted. From experience in the Cumberland region, Md., with the daylight furnaces, it was found that 1 pound of coal would heat 720,000 cubic feet of air 1° F. The amount of heat utilized is 13,126 B. T. U. Assuming 15,800 B. T. U. per pound of coal, the efficiency is $\frac{13{,}126}{15{,}800} = 83$ per cent., a loss of 17 per cent., which agrees with that found in steam boiler plants (See Box).

In summer, the mine furnace under consideration heats 30,000 cubic feet of air per minute from 66° to 325° = 259°, or 7,770,000 cubic feet 1 degree.

Amount of coal burned per minute

$$\frac{7{,}770{,}000}{720{,}000} = 10.8 \text{ pounds}$$

Amount of coal burned per hour

$$= 10.8 \times 60 = 648 \text{ pounds}$$

In winter, the conditions being more favorable, the gas in the stack need not be so hot. To find what temperature will give 1.86 = T. A. H. needed we have

T. A. H. = 82 ft. atmos. @ 0° − 82 ft. hot gas @ $x = 82 \times .0864 - 82 \times x$;

T. A. H. $= 1.86 = 7.0848 - 82 \times x$;

$$x = \frac{7.0848 - 1.86}{82} = .0637 \text{ lb.} = 162°.$$

In winter then the mine furnace heats 30,000 cubic feet air from 56° to 162°, or 106°, or 3,180,000 cubic feet 1 degree.

Amount of coal burned per minute

$$= \frac{3{,}180{,}000}{720{,}000} = 4.42 \text{ pounds.}$$

Amount of coal burned per hour

$$= 4.42 \times 60 = 265 \text{ pounds}$$

Amount of Coal Burned Per Square Foot of Grate Surface.—The Hetton colliery gives 7.5 pounds per square foot grate surface per hour. The Morfa colliery gives 9.3 pounds per square foot. The Cumberland region with daylight furnaces show $6\frac{1}{2}$, 7.14, 8, and 13.4 pounds per square foot. We will assume 12 pounds per square foot grate surface per hour.

$$\text{Area grate surface} = \frac{648}{12} = 54 \text{ square feet.}$$

There seems much diversity of opinion as to the length of grate bars. In 10 furnaces they run from 5 feet to 10 feet. Assume $8\frac{1}{2}$ feet long. This with a patent shaking grate attachment would make a fine arrangement.

$$\text{Width of grate bars} = \frac{54}{8.5} = 6.35,$$

say $6.33 = 6\frac{1}{3} = 6$ ft. 4 in.

Length of flue from flame bridge to stack: If too long, heat is lost that would serve better in the stack; if too short, the proper admixture of the gases does not take place. The Cumberland region practice has been to let this length equal the length of grate bars and flame bridge (in this case $8\frac{1}{2} + 2 = 10\frac{1}{2}$ feet). A rise of 1 inch in 6 has given good results:

Dimensions of Structure.—What dimensions must be given to this structure to make the entire resistance of the air through the same (from front of grate bars to top of stack) equal to .62 pound per square foot?

In these furnaces all the air goes over the fire, except what draws naturally through the bars and fuel.

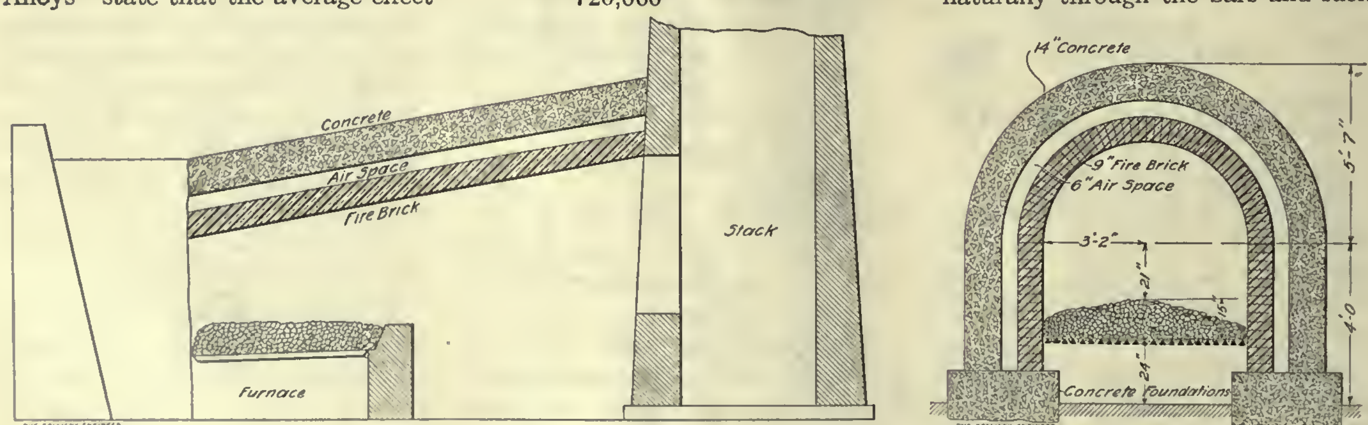


FIG. 2. ELEVATION OF FURNACE, AND CROSS-SECTION AT FIRE BOX

Also summer conditions being unfavorable, summer conditions should obtain. The equation for chimney draft is (p. 287, Rankin's "Steam Engine").

$$\text{Stack resistance} = h = \frac{u^2}{2g}\left(1+\frac{fl}{m}\right) - \frac{v^2}{2g} \qquad \text{(A)}$$

Where,

h = feet in hot gas @ 325°;

u = velocity hot gas in flue and stack, feet per second ($u=18.6$; $u^2=345.96$);

$2g$ = gravity = 64.40;

f = coefficient of friction hot gas = .0172 (empirical);

l = length furnace, flue, and stack in feet (102.57);

$m = \frac{\text{mean area}}{\text{mean perimeter}}$;

v = velocity of approach of mine air to furnace ($v = 6.69$; $v^2 = 44.76$).

u, l, m, and v cannot be known unless the size of stack and approach is known. Assume a square stack, $6\frac{1}{3}\times6\frac{1}{3}=40.10$ square feet area.

To determine value of u: In summer the mine air was raised from 66° to 325°, and in order to keep u the same throughout the whole structure, the area of the air passage from the front of grate bars to the flue hole in the stack must increase in the same proportion.

Vol. @ 325° = 1.597
Vol. @ 66° = 1.069
.528

$$\frac{.528}{1.069} = 49\tfrac{4}{10} \text{ per cent. increase}$$

$30,000+49\frac{4}{10}$ per cent. of $30,000 = 30,000+14,820 = 44,820$ cubic feet of hot gas.

$$u=\frac{44,820}{60\times40.10}=18.6 \text{ feet per second; } u^2=345.96.$$

To determine the value of u: The area over fuel at grate-bar front must be $\frac{40.10}{149.4}=26.84$ square feet. We can now construct the section at that point (see Fig. 2).

The double arches go back to the stack, the outer arch extends in front beyond the grate bars and inner arch, 8 feet, forming, with its piers, the "approach" whose velocity is v.

Area over fuel must be 26.84 square feet.

Area semicircle 6 ft. 4 in. $d = 15.75$;

$26.84-15.75=11.09$;

$$\frac{11.09}{6.33}=1.75 \text{ feet} = 21 \text{ inches}$$

Area "approach" = area semicircle d = 8 ft. 10 in. = 30.64

Area rectangle $8.83\times5 = 44.15$

74.79 square feet

$$v=\frac{30,000}{60\times74.79}=\frac{500}{74.79}=6.69 \text{ feet per second; } v^2=44.76.$$

To determine value of l: Assume the stack flue hole to be $6\frac{1}{3}$ ft. $\times$ $6\frac{1}{3}$ ft. = 40.10, the assumed stack area, and its bottom side 5 feet above the ground, and the stack walls 3 feet thick with $\frac{3}{8}$-inch batter. The total height of stack above ground is $82+1.25+2=85.25$ feet.

l = 10.50 ft. = grate bars $8\frac{1}{2}$ + bridge 2 ft.
10.50 ft. = flue length
2.67 ft. = thickness stack wall at center square hole (3–4 in. batter)
4.98 ft. = $\frac{1}{4}$ circumference of circle 6 ft. 4 in. diameter
73.92 ft. = 85.25 – (5+6.33)
102.57 ft.

To determine m:

$$m=\frac{\text{area}}{\text{perimeter}}=\frac{40.10}{25.33}=1.58$$

Substituting these values in equation (A):

Stack resistance:

$$=h=\frac{345.96}{64.40}\left\{1+\frac{.0172\times102.57}{1.58}\right\}-\frac{44.76}{64.40};$$

$h = 5.372\,(1+1.116) - .695 = 5.372\times2.116 - .695;$

$h = 11.367 - .695 = 10.672$ feet hot gas @ 325° = $10.672\times.0506$ = .54 pound per square foot.

As we allowed .62 pound for stack resistance, it would seem that perhaps a slightly smaller stack might answer (as perhaps a 6 ft. $\times$ 6 ft.) but as the width of the grate bars is 6 feet 4 inches it is better as it is.

We now have,

Mine drag = 1.32 pounds
Stack resistance = .54 pound
T. A. H. = 1.86 pounds

$$\frac{\text{Stack resistance}}{\text{Mine drag}}=\frac{.54}{1.32}=41 \text{ per cent.}$$

$$\frac{\text{Stack resistance}}{\text{T. A. H.}}=\frac{.54}{1.86}=29 \text{ per cent.}$$

As the assumed mine drag was 1.24 pounds this larger head 1.32 pounds will bring an increase of air, viz.:

$$30,000 : Q = \sqrt{1.24} : \sqrt{1.32} = 1.1136 : 1.149$$

$$Q=\frac{30,000\times1.149}{1.1136} = 30,954$$

cubic feet air per minute

The interior dimensions of this structure have now been determined.

Below are given actual experiments taken at several daylight furnaces by the writer, showing how the stack resistance and the mine drag were determined:

Experiment No. 1.—This daylight furnace was situated 30 feet above the inlet, rise workings.

Height stack = 55 feet above flame bridge.

Outside temperature = 32°.

Mine air (average) = 45°.

Mine air at furnace = 56°.

Grate area = 6 ft. $\times$ 7 ft. = 42 square feet.

Hot gas temperature = 380°.

Water gauge $=\frac{3''}{20}=.779$ pound per square foot.

Quantity of air = 20,247 cubic feet per minute.

T. A. H. = 85 ft. atmos. @ 32° – 30 ft. mine air @ 45° – 55 ft. hot gas @ 380°;
$= 85\times.0807 - 30\times.0786 - 55\times.0474 = 6.860 - 2.358 - 2.607 = 1.895$ lb. per sq. ft.

Let

M. D. = mine drag;

S. R. = stack resistance;

W. G. = water gauge;

W = weight column atmospheric air the height of stack;

W_1 = weight column hot gas the height of stack;

W_2 = weight column atmosphere equal to different level between furnace and inlet;

W_3 = weight column mine air equal to different level between furnace and inlet.

Then,

M. D. = (W_2-W_3)+W. G. = 2.421 −2.358+.779 = .842 lb. per sq. ft. = $44\frac{4}{10}$ per cent. of T. A. H.

S. R. = $(W-W_1)$−W. G. = 4.439 −2.607−.779 = 1.053 lb. per sq. ft. = $55\frac{6}{10}$ per cent. of T. A. H.

T. A. H. = 1.895 lb. per sq. ft. 100 per cent.

This was one of the earlier furnaces, and it will be noticed that it takes more head to pass the air through the furnace than through the mine. It is too contracted, evidently.

The amount of coal burned per square foot of grate per hour was

$$\frac{20{,}247\times324\times60}{720{,}000\times42}=13 \text{ pounds.}$$

Experiment No. 2.—This daylight furnace was located 31.9 feet above the inlet, rise workings.

Height stack = 79.9 feet.

Outside temperature = +10°.

Mine air (average) = 48°.

Mine air @ furnace = 56°.

Grate area = 6 ft. × 9 ft. = 54 square feet.

Hot gas temperature = 180°.

Water gauge $=\frac{9''}{40}=1.168$ pounds per square foot.

Quantity of air = 31.680 cubic feet per minute.

T. A. H. = 111.8 ft. atmos. @ +10° −31.9 ft. mine air @ 48° −79.9 ft. hot gas @ 180°;
= 111.8 × .0846 − 31.9 × .0782 − 79.9 × .0620
= 9.46 − 2.49 − 4.95
= 2.02 lb. per sq. ft.

M. D. = (W_2-W_3) + W. G. = 2.70 − 2.49 + 1.168 = 1.378 lb. per sq. ft. = $68\frac{2}{10}$ per cent. of T. A. H.

S. R. = $(W-W_1)$ − W. G. = 6.76 − 4.95 − 1.168 = .642 lb. per sq. ft. = $31\frac{8}{10}$ per cent. of T. A. H.

T. A. H. = 2.020 lb. per sq. ft.

Notice the reduction of the stack resistance, this furnace being made more ample. The amount of coal burned per square foot of grate per hour is

$$=\frac{31{,}680\times124\times60}{720{,}000\times54}=6.07 \text{ pounds.}$$

Experiment No. 3.—This is a June month experiment on the same furnace as in No. 2.

Outside temperature = 64°.

Mine air (average) = 64°.

Mine air at furnace = 66°.

Hot gas temperature = 245°.

Water gauge $=\frac{2''}{10}=1.042$ pounds per square foot.

Quantity of air = 27,588 cubic feet per minute.

T. A. H. = 111.8 ft. atmos. @ 64° −31.9 ft. mine air @ 64° −79.9 ft. hot gas @ 245°;
= 79.9×.0758 − 79.9×.0563
= 79.9 × .0195 = 1.558 lb. per sq. ft.

M. D. = (W_2-W_3)+W. G. = 2.42 −2.42 + 1.042 = 1.042 lb. per sq. ft. = $67\frac{2}{10}$ per cent. of T. A. H.

S. R. = $(W-W_1)$−W. G. = 6.056 −4.498−1.042 = .516 lb. per sq. ft. = $32\frac{8}{10}$ per cent. of T. A. H.

T. A. H. = 1.558 lb. per sq. ft. 100 per cent.

The stack resistance still keeps $\frac{1}{3}$ and mine drag $\frac{2}{3}$ of the T. A. H.

The amount of coal burned per square foot of grate surface per hour

$$=\frac{27{,}588\times179\times60}{270{,}000\times54}=7.62 \text{ pounds.}$$

Experiment No. 4.—This daylight furnace was built to ventilate one side of a small mine. Its location was on a steep hillside, so the grate bars were placed in the stack itself, and the stack connected with the mine by a short length of arched masonry 40.66 feet above inlet, rise workings.

Height stack = 62.81 feet.

Outside temperature = 65°.

Mine air (average) = 56°.

Mine air at furnace = 64°.

Grate area = 5 ft. × 5 ft. = 25 square feet.

Hot gas temperature = 280°.

Water gauge $=\frac{2''}{10}=1.039$ pounds per square foot.

Quantity of air = 9,078 cubic feet per minute.

T. A. H. = 103.47 ft. atmos. @ 65° −40.66 ft. mine air @ 56° −62.81 ft. hot gas @ 280°;
= 103.47 × .0757 − 40.66 × .0770 − 62.81 × .0536
= 7.833 − 3.131 − 3.367
= 1.335 lb. per sq. ft.

M. D. = (W_2-W_3)+W. G. = 40.66 ×(.0757−.0770)+1.039 = .986 lb. per sq. ft. = $73\frac{9}{10}$ per cent. of T. A. H.

S. R. = $(W-W_1)$−W. G. = 62.81 ×(.0757−.0536)−1.039 = .349 lb. per sq. ft. = $26\frac{1}{10}$ per cent. of T. A. H.

T. A. H. = 1.335 lb. per sq. ft. 100 per cent.

The stack resistance, $26\frac{1}{10}$ per cent., was small, as might have been expected, there being no horizontal fireplace and flue.

The amount of coal burned per square foot grate per hour

$$=\frac{.9078\times216\times60}{720{,}000\times25}=6.53 \text{ pounds}$$

The writer once visited a large mine furnace built in the coal seam, and within the "danger line," for the mine had been on fire several times, once seriously, from the ventilation reversing, although a good fire was kept going day and night. It seemed to me very threatening. It did not seem as though the people could have understood the conditions, or they would never have built the furnace where it would be such a menace.

New Use for Naphthalene

The French have constructed motors for the use of naphthalene briquets. The naphthalene melts at 80° C., and below this temperature it is an inert body which, in the form of briquets, is stored without inconvenience. According to *L' Echo Des Mines*, the employment of naphthalene for small motors is very economical, 375 grams of refined naphthalene producing a gross impulse of one horsepower per hour. In small motors the consumption per horsepower is higher in proportion than in motors of more power. Naphthalene in this form costs \$1.80 for 220.5 pounds, or a little more than ½ per cent. per horsepower hour. As this is a coal-tar product from by-product coke ovens, it adds one more important product to the coke industry.

Storage-Battery Locomotives

What They Have Done—Analysis of the Conditions Under Which They May Be Profitably Installed

By Stewart S. Shive*

IT IS the object of this paper to describe storage-battery mine locomotives, to study their performances, and to analyze the conditions under which a storage-battery locomotive may be profitably installed. In many places where the mine is level or grades are favorable and where the haul is not extremely long, a storage-battery locomotive offers decided advantages over a cable-reel locomotive in the points of cost of operation.

The successful storage-battery mine locomotive is the result of many designs distributed through years of general development in the design of electric locomotives for mine service, and a few bits of history will show the reasons for early failures and recent successes.

Fig. 2 shows one of the earliest storage-battery locomotives built by the Jeffrey Mfg. Co. The frame of this locomotive is of cast iron, with the battery box set on top. The nominal weight was 4 tons. It was 36-inch gauge, had a 44-inch wheel base, and was 52 inches high. This locomotive was shipped to the Pocahontas Collieries Co., Pocahontas, Va., April 29, 1900. The battery consisted of 88 lead cells. It will be noted that the locomotive carried a trolley pole, which was for the purpose of operating the locomotive from the trolley as well as from the battery. An attempt was also made to charge the battery through a resistance while operating from the trolley, but this was not successful. The chief obstacle to this method of charging is the fluctuation of the trolley voltage with the load, and the difficulty of maintaining a proper value of charging resistance under all conditions. As a battery proposition, this locomotive failed to give satisfactory service, the chief reasons being that the battery was not sufficiently rugged and the motor was too inefficient as a battery motor.

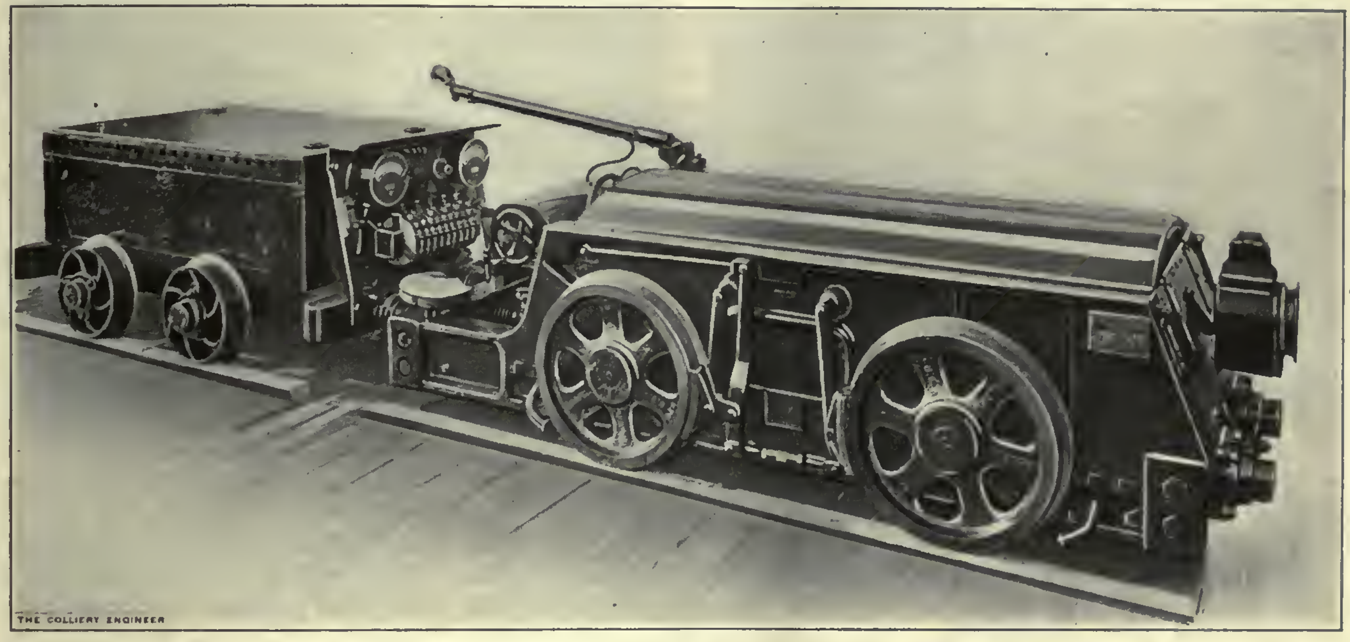


Fig. 1. Jeffrey Storage-Battery Locomotive With Trailer, Built in 1900

Fig. 1 shows a locomotive with the battery box carried on a trailer instead of being mounted on top of a frame as in Fig. 2. This locomotive was shipped to the Red Jacket Coal Co., December 12, 1900, but was not a success, and was finally returned in July, 1902. It failed also because of inadequate battery, and inefficient motor. These first attempts were not very encouraging, and although a more efficient motor was designed and built, the lack of a sufficiently rugged battery to stand the mechanical and electrical abuses incidental to mine service, retarded the progress of the storage-battery locomotive. With a more efficient motor, however, a number of locomotives were built for surface haulage.

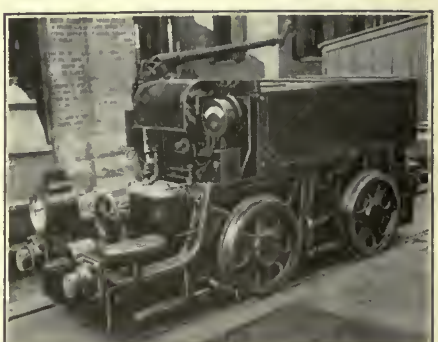


Fig. 2. Early Storage-Battery Locomotive

The operation of these locomotives was pronounced successful, but

*District Manager Jeffrey Mfg. Co.
Abstract of a Paper read at the Illinois Mining Institute.

it was not until the construction of a rugged storage battery that the locomotives could be applied to mine haulage with any degree of assurance as to success. Ruggedness, durability, and ease of up-keep are the factors of prime importance in a storage battery, and with these qualities available, the storage-battery locomotive applied to mine haulage promises a very interesting development. The two batteries most extensively used for this purpose are the Edison, and the Iron-clad Exide batteries.

The most recent storage-battery locomotive for mine haulage is represented by the installation in the Grant Coal Mining Co.'s mines at New Goshen, Ind. The six 5-ton locomotives in operation at this place are giving satisfactory service.

One of these locomotives is equipped with two motors; one motor driving on each axle through a four-lead steel worm meshing with the 34-tooth bronze worm-wheel, the whole being enclosed in a housing around the axle.

Fig. 5 shows this motor mounted on the axle with the lid on the worm housing raised for lubricating the worm-drive. Also the accessibility of the brushes and large commutators are shown in this figure.

The battery equipment consists of 63 A-8 Edison cells, which have an average discharge of 75 volts at normal discharge rate of 60 amperes. The motors operating in parallel and driving through gear reduction 16-inch diameter wheels, gives the locomotive a speed of 4.3 miles per hour at normal discharge rate. The locomotive is equipped with a series and parallel controller, so that on starting the motors may be connected in series, and under these conditions with twice the normal discharge rate, nearly 120 amperes, the locomotive will exert a tractive effort of 2,290 pounds. The brake mechanism is of the automatic screw locking type.

In the panel system of mining at the Grant mine, the storage-battery locomotives are used for distributing the empty cars to the rooms and hauling the loaded cars from the rooms to the double parting on the panel entry. The rooms, spaced on 35-foot centers, are worked 200 feet long. The average number of rooms on an entry is about 24, and the average distance between the first and last working rooms is about 400 feet. The average distance from the first room to the double parting on the panel entry is 450 feet. The cars are gathered from the rooms and taken to the double parting in trips averaging about 14 cars each, and from this double parting they are taken to the shaft bottom by a trolley locomotive. The general dip of the coal seam is eastward, and the average grade does not exceed 1 per cent. The mine is what would be called level, and is ideal in this respect for the installation of a storage-battery locomotive. The weight of an empty car is 1,600 pounds; the load weighs 3,600 pounds, making the total weight of a loaded car 5,200 pounds.

The average number of 14-car trips made by each locomotive per day of 8 hours, is 16, making 224 the average number of cars handled per day for each locomotive. Of these 224 cars, there is an average of 6 cars per day that are loaded with dirt. On this basis, each locomotive hauls out 392 tons of coal per day, making a total of six locomotives of 2,350 tons per day. The actual output over the tipple for the four locomotives, is about 2,200 tons per day, which is lower than the calculated output, because the work of some of the locomotives is probably lighter than the average as assumed above. One locomotive will take care of from 50 to 62 men.

While hauling a trip of 16 cars to the shaft bottom, the current consumed while operating on level track was noted to be 90 amperes. The current, when pulling this trip up a grade of about 1 per cent., was noted to be 160 amperes, and in going around a curve which was up a grade of about 1½ per cent., it was noted to be 220 amperes. The discharge rates of 160 amperes and 220 amperes were maintained for only short intervals while the discharge rate of 90 amperes was maintained quite constantly when hauling this trip. The normal discharge rate of 63 A-8 Edison cells is 60 amperes, so it will be noted that the above discharge rates are not excessive for the battery capacity of these locomotives.

The oldest of these locomotives has been in operation for more than a year. During this time, the only cost for repairs has been for one journal spring, a resistance grid, and a new wheel, parts which were broken by the locomotive jumping the track and ramming the rib. It has also been necessary to replace a few small insulating bushings on the cells. The total cost of these repairs has not exceeded $5. It is only after a year of continuous service that it will be necessary to replace the electrolyte in the battery.

It is necessary with this kind of batteries to keep the tops free from incrustations of potash, and this is accomplished at this place by greasing the tops of the cans with a hard oil. This prevents the potash from adhering to the can, and it may be blown off with a jet of compressed air. By blowing it off every other day, the tops of the cells are kept perfectly clean. The electrolyte in the cells must also be kept above the tops of the plates, and this is accomplished by adding water every other day, at the same time that the tops of the cans are cleaned with the compressed-air jet.

The storage-battery locomotive must be given a little more attention and intelligent care than the plain trolley locomotive: The battery must be charged every night and although there are automatic devices for disconnecting the battery from the charging circuit when it is fully charged, it is nevertheless necessary to investigate the condition of the battery at this time. As the daily work which the battery performs varies, its condition of discharge at the end of each day will vary, and therefore, a different amount of charge will be required

to put the battery in shape for service on the following day.

There are two methods by which the condition of the battery may be ascertained: One is by means of the volt-ammeter which will indicate the voltage across the battery at any particular rate of discharge. Familiarity with the electrical characteristics of the battery will enable the observer to tell from the indications of the voltmeter and the ammeter the conditions of discharge from the battery, and the charge required to fully recharge the battery.

The other method is by means of an ampere-hour meter which records by a rotating hand on the circular dial, the number of ampere hours taken out of the battery. When the battery is in a fully charged condition the hand on this ampere-hour meter stands at zero, and as the battery is discharged, the hand rotates over the circular scale, indicating on this scale the number of ampere hours taken out. For example, the ampere-hour capacity of the A-8 Edison cell, is 300 ampere hours, and so the operator knows that when the hand in the circular dial approaches the 300 mark, the charge in the battery is becoming very nearly exhausted. When being charged, the hand moves backward over the scale until it again stands at zero. These ampere-hour meters may be provided with an electrical contact at zero which will trip a circuit breaker in the charging circuit, and thus disconnect the battery.

At the Grant mine the locomotives are equipped with a volt-ammeter, and an attendant takes care of the battery while it is charging, cutting it out when the readings on the instrument indicate that the battery is fully charged. It requires 7 hours to fully charge an Edison battery at the normal rate, and it will discharge at the normal rate, in 5 hours.

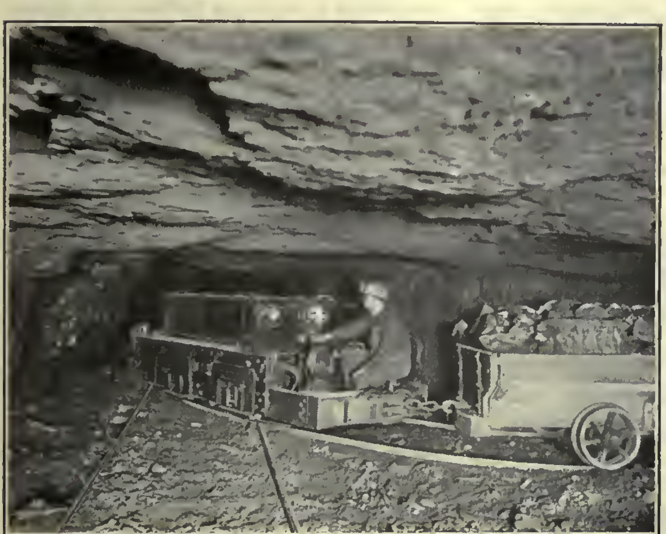


Fig. 3. Pulling Car Through Room Neck

Fig. 4. Storage-Battery Locomotive Hauling 16 Cars

In Fig. 7 is shown the motor barn and charging station at the Grant mine. To the right is shown the pit over which the locomotive stands when it is desired to inspect the equipment below the battery box. A chain hoist for handling battery boxes and locomotive parts is also shown. The charging panel at the back of the locomotive barn is wired for charging two batteries, which are connected in series with the resistance across the 250-volt line. The double-pole knife switch at the bottom of the panel is the main-line switch. The single-pole double-throw knife switch half way up connects the battery in series with the resistance across the line for charging when thrown up, and when thrown down it connects this same resistance across the battery terminals, so that the battery will discharge through it. By throwing this switch down, the operator may at any time note the condition of the battery by reading the ampere discharge rate and voltage across the battery terminal on the instrument, seen at the top of the instrument board. The small double-pole double-throw knife switches at the top of the board are instrument switches which enable the operator to use the instrument on either battery. In the center of the board is mounted a watt-hour meter which registers the watt hours consumed in charging both batteries. It is interesting to note that with the constant charging voltage which obtains at this place, it is not necessary to alter the charging resistance from the beginning of the charge to the end of the charge, this being adjusted once for all to give a normal charging rate, so that all that is necessary to charge the battery is to insert the charging plug in the charging receptacle in the upper left-hand corner of the battery box, and close the switches on the charging panel.

The charging resistance consists merely of open coils of a suitable resistance wire. At the entrance to the motor barn is another knife switch with 200-ampere fuses in each charging circuit.

The storage-battery locomotive shown on the front cover of this issue is taking a loaded car from the face. Note that the loaded car stands on a couple of wooden ties used for the time being as rails, and

the locomotive stands on a couple of rails thrown down for the time being with the web horizontal, so that the flanges on the locomotive wheels ride in the grove formed between the top and bottom of the rail. From the end of these pieces of rail, the motor moves itself and the loaded car on to track laid in the regular way. Attention is here called to this to show the great adaptability of the storage-battery locomotive to run anywhere track is laid, and sometimes where it is not laid.

Fig. 3 shows the locomotive pulling a loaded car out through the room neck to the entry.

Fig. 4 shows a locomotive hauling a train of 16 cars down the main entry. In a regular day's work this haul is made by a trolley locomotive, as the trolley wire shown in the picture indicates, but it shows nevertheless the possibility of hauling such a trip in the absence of a trolley locomotive.

Fig. 8 shows three of the battery locomotives in the brick tunnel at the bottom of the shaft. This whitewashed tunnel, about 200 feet long, is lighted by a system of indirect illumination. The illustration shows a storage-battery locomotive coming in with a loaded trip on each of the side tracks, and while there are two storage-battery locomotives returning down the middle track, only one is shown clearly.

Obviously the amount of electrical energy which it is required to store in a battery varies with the amount of work the locomotive must perform, and this depends on the distance and the grades over which the load is hauled.* Therefore it is necessary that a correct battery equipment be determined for each installation.

The size of battery with which it will be necessary to equip a locomotive is derived from two separate considerations, and the size of battery chosen will be a maximum given by either one. First, the speed at which the maximum drawbar pull must be developed furnishes a basis on which to estimate the size of the battery. If 60 per cent. be assumed as the average overall efficiency of the locomotive, we may write the following equation:

$$\frac{(\text{D.B.P.})\times(\text{M.P.H.})\times 5{,}280\times 746}{60\times 33{,}000\times .60}=EI$$

In which D. B. P. represents the drawbar pull, M. P. H. represents the miles per hour, E represents the voltage across the battery, and I the current discharge across the battery. Transposing E in this equation and

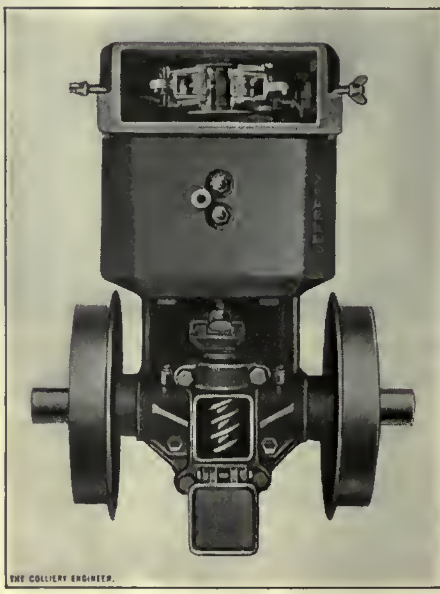


Fig. 5

reducing, the following form is obtained for the current discharge from the battery:

$$I=3.32\times\frac{(\text{D.B.P.}\times\text{M.P.H.})}{E}$$

Knowing the maximum drawbar pull required and the miles per hour desired, this equation gives the current discharge from the battery at any given voltage. The value of E will depend on the voltage available for charging, upon the motor equipment of the locomotive, or upon some special condition under which the locomotive must operate, such as a gaseous mine which makes it desirable to have a low-voltage equipment. If the value of the current thus obtained will be required almost continuously, then a battery should be selected whose normal discharge rate is not less than half of the current thus obtained and preferably not less than this value divided by $1\frac{1}{2}$. If the maximum drawbar pull which the above value of current gives is to be exerted intermittently then the normal battery current will be one-third of the value obtained, and if the maximum drawbar pull is to be exerted momentarily, it is possible to select such a battery that its normal discharge rate will be only one-fourth or even one-fifth of the value obtained from the equation. In general it will be safe to so choose a battery that its normal discharge rate will be one-third of the value calculated.

The next step, which is the calculation of the size of battery on the kilowatt-hour basis, is by far the more important, and is really the way in which the size of the battery in most cases will be determined, unless in order to develop the necessary drawbar pull from the battery determined in this way, the current discharge from the battery will be too greatly in excess of the normal discharge rate.

The power taken from the battery may be divided into two parts, namely, that required to haul the train of cars, and that required to haul the locomotive. By this means, it is possible to reduce the entire route over which the locomotive and cars travel to an equivalent length of haul for the locomotive and an equivalent haul for the train.

For convenience, the route of the locomotive in its work of gathering coal will be divided into three parts. The first part is the distance L from the double parting on the main entry or panel entry, to the first room worked on the room entry.

The second part will be considered as the distance D on the room entry from the first room worked to the last room worked.

The third part of the route consists of the rooms in which the coal is mined, and the maximum length of these rooms will be denoted by d.

As a basis to work from, the power is determined that is required at the battery per ton of locomotive weight to haul the locomotive alone

*The condition of the cars, and roadbed are also factors which the author includes later in the article.

forth and back on 1,000 feet of track for various grades, and also the power required at the battery per ton of loaded train to haul a train forth loaded and back empty on 1,000 feet of track for various grades. Without going into the details of the calculation of these data, an over-all efficiency of 60 per cent. is assumed for the locomotive, a rolling friction of 20 pounds per ton for the locomotive, and 30 pounds per ton for the cars. For each per cent. of grade an additional tractive effort of 20 pounds per ton is required for both locomotive and cars. The ratio of the weight of an empty car to the weight of a loaded car is assumed to be .4, and is approximately constant for all weights of cars.

On these assumptions, the power required under various conditions as outlined have been calculated, and the results plotted in the form of curves shown in Fig. 6. In order to apply these curves to a locomotive gathering coal in a mine, it will be assumed that the train hauled to and from the parting in the main, or panel, entry consists of n cars. The only part of the route, however, over which the complete train of n cars is hauled as a unit is from the parting to the first room worked. From there on the train is not hauled as a unit, but cars are dropped off, pushed into the rooms, hauled out, and picked up in the process of gathering. These operations may be reduced so far as power consumption is concerned, to an equivalent length of haul for the locomotive, and an equivalent length of haul for the complete train n cars. Then the curves may be readily applied and the calculation easily made.

The data on the first part of the route as outlined above and designated by L is already in the desired form, and the length of haul for both locomotive and complete train of n cars is L.

For the second part of the route, namely, on the room entry between the first and last room worked, it is evident that the locomotive traverses each portion of the track only once in each direction for each trip, and consequently the length of haul for the locomotive for this portion of the route is simply the distance between the first and last rooms worked, or D. The distance over which the entire train of n cars may be considered as being hauled on this portion of the route will be the

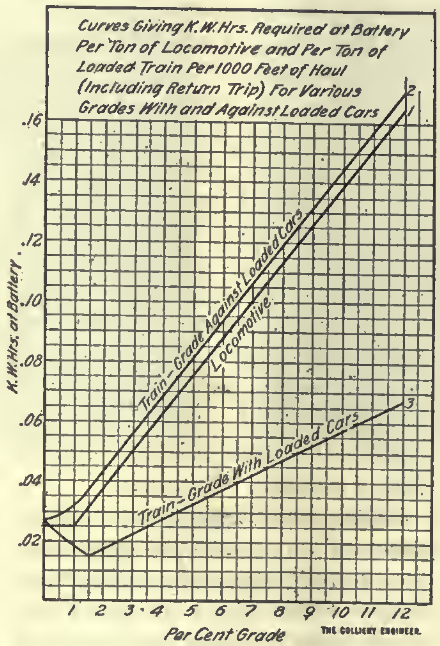


FIG. 6

average distance each car is hauled or $\frac{D}{2}$. Since each car returns loaded over exactly the same track it traverses empty, it is evident that the curves may be at once applied to this part of the route in the same manner they are to the first part.

Considering the third part of the route, namely, that in the rooms, if the first room worked is of the maximum length d, and the rooms gradually decrease in length until the last room is just being started, then the average length of the rooms will be $\frac{d}{2}$. Such a uniform variation in depth of rooms, however, does not actually exist. The average depth is greater than $\frac{d}{2}$, and in order to cover such switching operations as are necessary in the rooms, the average depth of room is taken equal to d. One car is handled in each room and the work per trip in handling cars in rooms is equivalent to hauling one car a distance of $n\,d$, or a train of n cars a distance of d. The equivalent of length of haul for the train of n cars then on this part of the route is d.

The locomotive of course has to enter every room where a car is handled, and obviously the equivalent length of haul for the locomotive on this part of the route is $n\,d$. This part of the route is thus reduced to equivalent lengths the same as the other parts; and to apply the curves the average grade and the equivalent length of haul is used for each section of the route for both locomotive and train.

The equivalent lengths of haul may be summarized as follows:

Part of Route	Equivalent Length of Haul	
	Locomotive	Train
Parting to first room........	L	L
One room entry in front of rooms..................	D	$\frac{D}{2}$
In rooms..................	$n\,d$	d

As an example of the application of these curves, the work done by the storage-battery locomotives at the Grant mine may be checked. In the data on this installation, the value of L was given 450 feet, the value of D was 400 feet, the value of n was 14, and the value of d was given as 200 feet.

The locomotive weighs 5 tons, and a trip of 14 loaded cars weighs 36.5 tons. Inasmuch as the grades are practically the same on all parts of the route, it will not be necessary to figure out each part separately from the curves, but the complete equivalent length of haul for the locomotive for all three parts of the route may be taken, and also the complete equivalent length of haul for the train for all three parts of the route may be taken. The equivalent length of haul then for the locomotive will be $L + D + n\,d$ = 3,650 feet. The equivalent length of haul for the train will be $L + \frac{D}{2} + d$ = 850 feet.

It was stated that the average grade would not exceed 1 per cent. In some places this grade will be against the load, and in some places it will be in favor of the load. In order to be on the safe side, it will be assumed that this grade is always against the load.

Referring then to the curves in Fig. 6 the 1-per-cent. grade is located on the horizontal scale. Going up along 1-per-cent. line to the curve labeled "locomotive," we read on the vertical scale the kilowatt hours required at the battery to haul 1 ton of locomotive weight 1,000 feet forth and back on this grade. This value of kilowatt hours at the battery is found to be .025. For a 5-ton locomotive this value is multiplied by 5, and for the equivalent length of haul for the locomotive, it is further multiplied by 3,650 ÷ 1,000 = 3.65. The result is that .456 kilowatt hour is required per trip to operate the locomotive.

Referring again to these curves, and following the 1-per-cent. line until it intersects the curve labeled "train grade against the loaded cars" it is found that .032 kilowatt hour is required to haul 1 ton of loaded train forth and back over a distance of 1,000 feet with a grade of 1 per cent. against the load.

Since the loaded train weighs 36.5 tons, and the equivalent length of haul is 850 feet, multiply this value of .032 obtained from the curves by 36.5 and .850, which gives .993 kilowatt hour required per trip to haul the loaded cars. Adding the values obtained for hauling the locomotive and the loaded cars, gives 1.449 kilowatt hours per trip. In order to allow for decreased kilowatt-hour capacity of the battery when discharging faster than the normal discharge rate, and to provide for reasonable emergencies such as switching on the entry, pulling cars back on the track, excessive starting and stopping, running with brakes set part of the time, etc., the kilowatt-hour capacity thus obtained is multiplied by the factor 1.35 to give the kilowatt-hour capacity at the normal discharge rate required of the battery, thus the kilowatt-hour capacity required in this case becomes 1.95. The normal kilowatt-hour capacity of 63 A-8 Edison cells is 22.5 kilowatt hours and dividing this by 1.95 will give 11 trips for the locomotive on a single charge of the battery.

The actual performance of the battery locomotive is better than this, for the locomotive handled 16 trips averaging 14 cars in a working day of 8 hours. There are several reasons for this, the chief of which is probably that the cars instead of being equipped with ordinary bushed journals as was assumed when 30 pounds rolling friction per ton was used in calculating these curves, are equipped with roller bearings which have a roller friction far less than 30 pounds per ton. In the calculation the average grade was assumed to be 1 per cent. against the load, which is greater than is actually the case.

Again, track conditions in this mine are very good, the locomotives are carefully operated and discharge rates on the battery are not excessively high, therefore the factor 1.35 is probably greater than necessary in this case. All of these points would tend to raise the performance of the locomotive above what is calculated. The calculation, however, will be accurate for average conditions where ordinary cars are used, where track conditions are not extremely good, and where the locomotive is operated with some degree of carelessness.

A comparison between the calculated performances and actual performances shows that it pays to keep equipment in first-class shape when operating storage-battery locomotives, for the output of such a locomotive can be greatly increased by a little attention to car wheels and track conditions. Roller bearing wheels in themselves will effect a considerable increase in the output of the locomotive.

If, for example, in the above case it is assumed that the roller friction of the cars equipped with roller bearings is 15 pounds per ton instead of 30 pounds per ton assumed with bushed journals, then the power consumed by loaded cars per trip will be only .644 kilowatt hour instead of .994, the total power consumed per trip after multiplying by the factor 1.35 will be 1.485 kilowatt hours, and the number of trips which the locomotive will make on a single charge would be 15 instead of 11, as obtained with ordinary bushed journals. This last result comes nearer to the actual performance of the locomotive, and with good track conditions the performance obtained is nothing more than should be expected. The importance of roller bearing cars where storage-battery locomotives are used, cannot be overemphasized.

It will be found on comparison that there is little difference in the cost of operation between storage-battery locomotives and cable-reel locomotives. In some cases the difference favors the cable-reel locomotive, and in other instances it favors the storage-battery locomotive. In general where the operation of the locomotive is confined to a single panel entry, where the haul of the locomotive is not long, and where the territory worked is not distant from the power house, the cost of operating a storage-battery locomotive will be somewhat greater than the cost of operating a cable-reel locomotive. If, however, the locomotive handles the output of several entries, and the haul is of considerable length, say 1,000 feet, and the territory operated is at a considerable distance from the power house, say a mile, then it will be found that the cost of operating a storage-battery locomotive will be less than that of operating a trolley locomotive.

The cost of operating a cable-reel locomotive may be divided into three charges. First, the fixed charges on the locomotive including interest, depreciation, and repairs. Second, the fixed charges of the bonding material, trolley supports, trolley and accessories, these fixed charges including interest, deprecia-

tion, and wages of linemen. Third, the fixed charges of feeders, including interest, depreciation, and repairs.

The first fixed charges depend upon the size and number of locomotives installed. The second fixed charges depend upon the extent of the territory which these locomotives cover, and the third fixed charges depend upon the location of the territory with respect to the power house. It is evident, therefore, that the more extensive the territory over which a given locomotive operates, the greater will be the fixed charges coming under the second head, and the more remote the territory is from the power house, the larger will be the feeder required, and the larger will be the fixed charges coming under the third head.

The cost of operating a storage-battery locomotive may be divided into two divisions. The first of these will be the fixed charges on the locomotive, without the battery, and under these fixed charges will be included interest, depreciation, and repairs. The second charge will be against the batteries and will include interest, depreciation, repairs, and the wages of an attendant. The fixed charges of a storage-battery locomotive of given capacity are obviously independent of either the extent or location of the territory in which it operates. It will be noted that in both cases the cost of power is omitted.

It is safe to say that cable-reel locomotives are employed in a great many cases with greater consumption of power than would be the case if storage-battery locomotives were doing the same work, simply because of poor voltage at the place where the locomotive is operating, and because the full-load rates speed of a cable-reel locomotive being 6 or more miles per hour, makes it necessary to operate on resistance the largest part of the time.

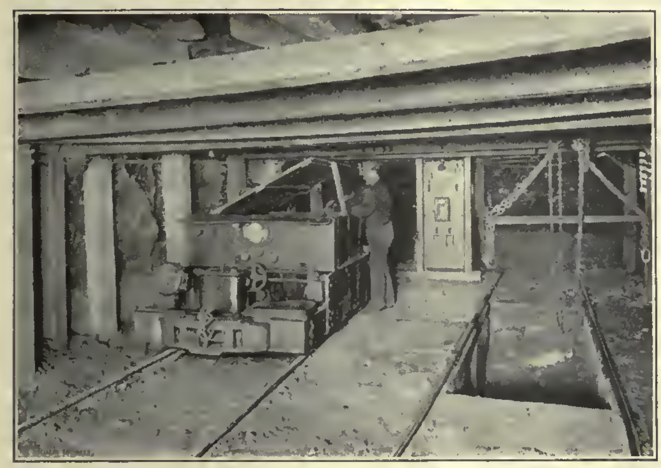


Fig. 7. Locomotive Barn at Grant Mine

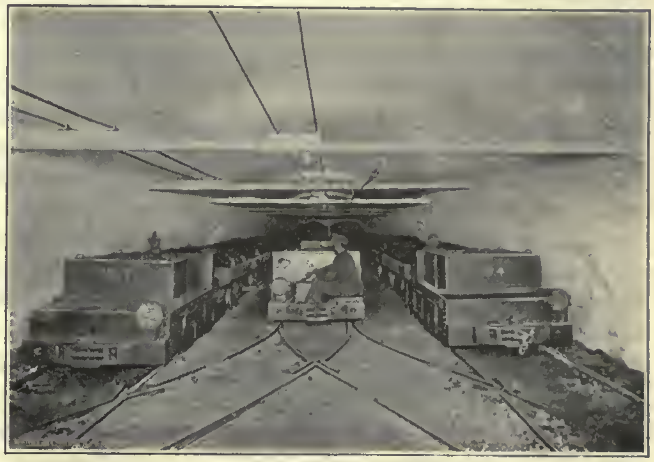


Fig. 8. Locomotives in Brick Tunnel

Two typical sets of figures on comparative costs of operation of cable-reel locomotives and storage-battery locomotives will serve to illustrate what has been said in regard to the difference in cost depending upon the extent and location of the territory in which the locomotive is to operate. The first set of figures covers an installation of four locomotives operating very near the bottom of the shaft and close to the power house, so that no feeders are necessary, and each locomotive is operating in a single panel entry, the length of which is not over 500 feet. In this case the figures will indicate that an actual saving of $765 would be effected by the use of cable-reel locomotives. The second set of figures covers four similar locomotives operating at a distance of 4,000 feet from the power house. Each locomotive serves the output of three panel entries, and the length of these entries is 1,000 feet. In this case it is necessary to instal more bonding, more trolley supports, trolley and accessories, than in the first case. It is also necessary to install feeders, which were not necessary in the first case. The result is that the second example shows a saving of $889 effected by the use of storage-battery locomotives.

An item which is not given consideration in these figures is that often with the use of storage-battery locomotives, it is possible for the motorman to operate the locomotive and handle the cars, whereas with the cable-reel locomotives it is always necessary to have two men on the locomotive. Thus, it is often possible to save the wages of one man by the installation of a storage-battery locomotive.

Theory and practice point with assurance to the practicability of supplying storage-battery locomotives to the gathering of coal in mines under the proper conditions. It must be understood that the application is not general, but where conditions are favorable a storage-battery locomotive may be applied with positive assurance that its work will be satisfactory and economical.

W. P. Kyle, writing from Calgary, Alberta, Canada, says they have oil wells in that country which spout pure gasoline. He considers that the Calgary well product is better than the Pennsylvania well product. If Alberta keeps up with this sort of thing it will become the richest mineral province in Canada.

Origin of the Principle of Stone Dusting

*By W. E. Garforth**

Until recent years there has been a great deal of doubt as to when inert dust was first used to extinguish flame and prevent the production of poisonous gases resulting from a colliery explosion, but in the "Final Report of the Commission on Accidents in Mines (1886)," certain precautions are recommended and it concludes with the following statement:

"The observation recently made in Germany, in some prelimiuary experiments, that a thin layer of fine angular sand strewn over mine dust appeared to have the effect of preventing the communication of flame from a blown-out shot to all but the most inflammable dusts, is worthy of passing notice."

Later in the same year, Dr. W. N. Atkinson and Mr. J. B. Atkinson published "Explosions in Coal Mines," in which they recommended efficient watering; that haulage roads be kept free from coal dust, and that "In cases where there are special difficulties in the way of effectually removing or watering the dust on haulage roads, the bottom dust might be rendered uninflammable by an adulterant such as sand."

It was well known at that time that the most dangerous dust was the fine dust which was naturally carried by the ventilator to the upper part of the roadway, and it was often noticed that when the height of the roadway was increased by ripping the gray stone, the latter was soon covered by black coal dust.

The whole mining world is under deep obligations to the Messrs. Atkinson and to Prof. William Galloway for their persistent reiteration of the danger of coal dust.

With regard to systematic watering, experience has repeatedly proved that when water was applied to the roof and sides of the underground roadways it affected the strata injuriously and heavy falls resulted. Colliery owners in some coal fields believe watering a "remedy worse than the disease."

On July 18, 1908, a coal-dust flame about 170 feet long was produced in an experimental gallery in the same manner as in previous experiments. This gallery had been specially lengthened to provide for 300 feet of stone-dust zone with the dust placed on shelves in imitation of an underground roadway, so that the flame came into contact with the pulverized stone dust which was raised at the same moment as the coal dust or a cloud in the air. The stone dust presented to the explosive blast millions of superficial feet of inert or cooling surface, and extinguished the flame.

This experimental gallery was 7½ feet in diameter and 895 feet long; the detonation was heard for a distance of 4 miles.

At the present time there are roads in coal mines quite as safe as those in metalliferous mines, since 10 pounds or more of fine stone dust have been distributed for every pound of coal dust resting on the sides of the roadway and on the tops of the timbers—a quantity much in excess of the mixture of 1 pound of stone dust with 1 pound of coal dust, which experiments in the gallery proved to be sufficient to prevent an explosion.

To make the further experiments conducted recently more explicit, the following answers are submitted to hypothetical questions:

1. Is an underground roadway safe from an explosion if, after being stone dusted, it becomes again covered with a layer of coal dust?

By experiment it was found that it required the velocity of the air to be over 1,500 feet per minute to raise coal dust in a cloud, and that stone dust was not disturbed until a velocity of 2,600 feet per minute was reached. Now 2,600 feet per minute is 29.5 miles per hour. In the experimental gallery the lowest velocity recorded as the speed at which an explosion traveled was 120 miles per hour or four times faster than the air-current necessary to raise stone dust and coal as a cloud. The recorded rate of travel of violent explosions varies from 300 to 1,300 miles per hour. Hence, even if there were a layer of coal dust overlying stone dust, the whole would be raised by the "pioneering wave" of an explosion, and judging by experimental records the explosion would be stopped.

2. Can stone dust be applied to all places where coal dust is likely to be deposited?

The stone dust laden air-current distributed the dust on the roof timbers and in the intersections of the mines.

For example, to show how the stone dust may be carried by an air-current, 2½ tons of the dust were placed on a main intake road along which 90,000 cubic feet of air was passing per minute. A jet of compressed air was introduced into the heap of stone dust to raise the dust in the air-current. The heavier dust settled in the first 600 feet, but the lighter dust was carried for a distance of 2 miles, a larger proportion settling on the roof than on the floor.

3. What is the best kind of inert dust to use?

The opinion expressed by most experts and the results of microscopical tests show that the best material, from a physiological standpoint, is soft shale as free as possible from crystalline silica.

Stone dust by reason of its light gray color, readily shows any fresh deposit of coal dust. Its greater weight and its binding qualities allow it to be thrown in such a way as to displace coal dust from the ledges on which it rests, which lighter inert dusts are incapable of doing.

*An abstract of a paper read before British Institution of Mining Engineers.

Private Cars

The Pennsylvania Public Service Commission has decided that railroads cannot give lower rates to coal companies owning their own cars, than to shippers who use the railroad cars.

Miner's Oil Safety Lamps

Certain Qualities of Modern Oil Lamps That Render Them Preferable for Ordinary Use in Coal Mines

*By E. A. Hallwood, M. I. M. E.**

During the last few years the question as to the advisability of installing electric lamps in the coal mines of the United Kingdom has been a very live one.

The discussions in connection with the three big mining disasters of recent times, viz., Hulton, Whitehaven, and Senghenydd, no doubt had a great influence in bringing the electric lamp into prominence.

In the case of most comparatively recent disasters it has been customary to blame the miner's lamp. From observations and tests made, the writer cannot help but think that the lamp was looked upon as a very convenient article upon which to place the blame. The limited knowledge possessed by the average miner, manager, inspector, coroner, and juries on the behavior of safety lamps in the "midst of gas" gave to all concerned an easy and plausible thing upon which to place the blame in the event of there being nothing else convenient; or no doubt it was by some thought that by blaming the "lamp" it to some extent involved the men as being connected with the cause. There must obviously be some form of "light" in order to work the coal mines, and so long as there was no alternative the coal owner could rest content that he would get off easily if the blame could be saddled upon the lamp.

The writer was present during the explorations at the recovery of the Whitehaven colliery, and had an opportunity of examining in detail every miner's lamp which was recovered, and he has not the slightest hesitation in saying that there was not the faintest indication of any overheating of any of the lamps or damage to the lamps prior to the explosion, and yet the jury, without the slightest evidence, gave as the probable cause of the disaster the "overheating of a lamp." And yet in this mine there were many other possible causes. For instance, about the time of the recovery of the pit, matches were found on the top of one of the corves, and some time prior to the explosion a smell of tobacco smoke was detected by officials in the workings at the next pit (Croft pit) belonging to the same company.

From an examination of the evidence of other accidents, the writer is of opinion that the flame safety lamp has on many occasions been wrongly blamed. Excepting Scotland, bonnetted lamps have been in use almost exclusively in Great Britain. Experts demonstrated years ago that unbonnetted lamps would only withstand low velocities of explosive mixtures, yet there have been no very great disasters in Scotland, although, as stated above, it has been worked almost exclusively with unbonnetted lamps or naked lights. In the safety lamp mines of Scotland there must have been many occasions when lamps have been in explosive mixtures of gas, and yet no explosion has followed, so that evidently even this type of lamp must have a larger margin of safety than is commonly supposed.

To demonstrate that a gauze may be red hot and still not pass flame, I will conduct an experiment by taking an unbonnetted single-gauze lamp and pass coal gas into it through a Bunsen burner (forming an explosive mixture), it will be noted that although the inside of the lamp is filled with hot gas flame and the gauze is red hot yet the gas outside the lamp will not be ignited. To get an outside ignition with a bonnetted lamp the gas mixture must travel at such a velocity as is not usually available in a mine at a place where such a large quantity of gas is found; it will be obvious that if the gas be present at little velocity then the lamps are comparatively safe; again if the velocity be present but little or no gas, then there would be no danger. In this test I will drop fine coal dust on to and inside the lamp and it will be seen that even with gas and coal dust there is no outside ignition of gas, notwithstanding the fact that the gauze is red hot. The bonnet or hood now usually placed on safety lamps is an enormous extra factor of safety. The lamp so fitted will then not only withstand any mixture of gas but will also withstand any velocity of explosive gas which it could conceivably meet with in a mine. There are of course varying degrees of the margin of safety according to the design of the lamp. Some lamps will, even with single gauze and bonnet, withstand 2,400 or more feet per minute of explosive gas mixture, and the same lamps with double gauze will easily withstand an explosive mixture even when traveling at 3,500 or more feet per minute.

Many of the experiments and tests of miner's safety lamps, which are referred to by experts at inquests or in books on mining, have been conducted on an old Davy lamp or unbonnetted safety lamp, and under conditions which are quite unlikely to happen in a pit. Had bonnetted lamps been used, the writer is convinced that the results obtained would have been entirely different, and much of the unnecessary excitement and nervousness avoided.

In some tests carried out a few months ago by the writer in Pittsburg, U. S. A., he placed unbonnetted single-gauze safety lamps in an explosive mixture of natural gas and air and smashed the gauze of the lamp by blows from a large mallet, and in no single case was there an outside ignition. In other tests the glass of the lamp was shattered by blows from a long chisel and yet there was no external igni-

*Managing Director of Ackroyd & Best, Ltd., of Morley, near Leeds, England. Abstracted from a paper entitled "Miner's Oil Lamps vs. Miner's Electric Lamps," read at Mining Class of the Cambuslang School, Scotland, July 4, 1914.

tion. In all these tests the lamp was surrounded by an explosive mixture and gas flame was blazing in the gauze. In each case the shock of the blow or the movement of the mixture caused by the oncoming blow put out the flame in the lamp.

To illustrate my statement I will now proceed to another experiment. You will note that the lamp is the new combustion tube miner's lamp. I will place it in a chamber in which I will produce a mixture of 6 per cent. coal gas and air in which a cloud of fine coal dust is created. I will then pull the trigger of the spring pistol in the side of the chamber, and the steel pick pointed plunger of the pistol will completely smash the glass of the lamp, and you will observe that there is no external explosion. I will prove that this mixture is actually explosible by an electric lamp.

I may say that we have tested this combustion tube lamp in varying percentages of coal gas from 6¼ per cent. downward, and have never yet got an ignition from a broken glass. The lamp is invariably completely extinguished when the percentage of gas reaches 6¼ per cent., so that obviously an explosion cannot be got from a mixture above 6¼ per cent.

We have carried out experiments on our ordinary miner's lamp, and although we can keep the gas flame burning in the gauze at 7 per cent. we have not been able to get an external explosion. The shock of striking a lamp, even with the pick-like point of the spring pistol, extinguishes the lamp.

To show that an explosion can be easily produced by the ordinary portable electric miner's lamp as now offered for use in the mines of this country, I will now take samples of well-known makes of electric lamps, and using the same apparatus and same percentages of coal gas and coal dust and the same spring-pistol arrangement will easily create explosions by the smashing of the electric bulbs in the mixture. I may say we have got an explosion in this type of test by the smashing of the bulbs of portable 2-volt lamps in the midst of a mixture of as low as 3 per cent. coal gas, air, and coal dust. I think you will agree that this is a somewhat startling discovery. The ordinary open light may be moved about with impunity in a mixture of 3 per cent. of gas and air. In the tests on the safety lamp it was shown that 3 per cent. of gas, air, and coal dust has not been ignited, so far as the writer has been able to make out up to now; the possible explanation for the different behavior between miner's electric and the miner's oil lamp is that the former is burning in a vacuum and on the bursting of the bulb there is such a commotion in the air as to somewhat resemble a blown-out shot when fired into coal dust. It is well known that a blown-out shot will create an explosion when fired into coal dust and air only.

The bulb of an electric lamp is more likely to get smashed in a mine than is the glass in a safety lamp, and the bursting of the bulb might cause a rush inward of explosive gas or dust that would be ignited before the filament could cool.

In the event of a fall of roof, an electric lamp would retain its light right up to the moment of the bulb being smashed, and as shown in the tests this is sufficiently long to enable the gas to reach the red hot filament and become ignited. Not so with the flame lamp, the very movement of the air and gas in front of the fall seems to extinguish the lamp before it is smashed and so an outside ignition is avoided.

It is a very rare occurrence for a lamp to burn out in the mine. A careful man reaps the benefit of his care by scarcely ever losing his light by jerks, and does not complain at occasional loss of light owing to accidental stumbling. On the other hand, the careless man is justly punished for his carelessness by having more frequent extinguishments. The other cause of loss of light is by "gas," and no reasonable man will complain about his light being out by this means, seeing it compels him to get out of the danger zone. With modern safety appliances, extinguished oil lamps can now be safely and easily relit, so that there is no need to reject oil lamps on the score of "loss of light."

The property contained in the ordinary flame safety lamp of easy and quick detection of not only methane but of carbon dioxide and blackdamp is such as to alone make one hesitate at scrapping such an article. Many attempts have been made to supplant this device in testing for gas, but so far there is not a single device on the market which can approach the miner's gauze lamp for gas-detecting properties. With the experience which is now being gained by miners and officials at the numerous mining classes in the Kingdom, men are being trained to read very low percentages of gas with the ordinary safety lamp. Hitherto the testing for gas has been attended to by the officials, but now many miners know as well or better than the officials how to do this work, and with a spread of this knowledge there is no doubt that miners will for their "life's sake" see that in future mines are properly ventilated, and this will no doubt be one of the greatest factors in the reduction of disastrous explosions in the future.

At the Easington colliery, in Durham, a fatality recently occurred to men using the electric lamps; at the same pit a few days afterwards a similar fatality was narrowly avoided, and no doubt would have happened if the men this time had not been provided with oil safety lamps. There have already been several instances in other parts of the coal fields of Great Britain of men being fatally gassed whilst using electric lamps. We recently had to deal with a pit where there was so much blackdamp that even candles had difficulty in burning. Firedamp was found in this pit and the inspector ordered safety lamps to be used. In a pit where candles would only burn with difficulty it was natural to suppose that difficulty would be experienced with

safety lamps. Eventually electric lamps were got, and so far as we are aware the ventilation remains as it was, irrespective of whether it will eventually undermine the health of the miners. I think that if the miners were looking after their own interests they would have seen that they retained some check on the mine air.

Whilst dealing with this subject of headache, I will refer to the nystagmus of which so much has been heard during the last few years. Any person who has been troubled with aching eyes and aching head will sympathize with a miner suffering from this painful sickness, especially when during certain stages of its development the miner continues to work in hot, stuffy workings and often in cramped positions, each swing of the pick vibrates through the throbbing head until the man feels crazy; these are the times when, as previously stated, a man leaves undone the thing he ought to have done, and jeopardizes his own safety and the safety of his fellow men. To alleviate the pain caused such men should surely be a desirable thing, if in doing this expenses can also be avoided, and cleaner coal obtained, it should be worth the while of all concerned to install in a pit a lamp that will do it.

Several eminent doctors have stated that an illumination of 1 candlepower will prevent nystagmus. For some time it has been known that the ordinary miner's flame safety lamp does not give such an illumination. When, therefore, the statement was made that it would give 1½ to 2 candlepower, people naturally thought that nystagmus would disappear, but unfortunately it was overlooked that 1 candlepower with an electric lamp is not so useful to the eye as 1 candlepower from a flame. The rays from an electric lamp are cold, hard, and piercing, and reflect back light from the facets of the coal, and these are uncomfortable to the eye. I think time will show that 1 candlepower with an electric lamp will not prevent nystagmus.

In the *Iron and Coal Trades Review*, of March 6, 1914, Doctor Llewellyn, the eminent authority on nystagmus, is reported as having stated that "the one object of an electric light was the good light. The most essential point was candlepower. The Home-Office regulations only stipulated 1 candlepower, and there were very few electric lamps capable of producing 1 candlepower for 9 hours. He had conducted many experiments on electric lamps, and taken many photometric measurements, but personally he had never found one lamp which produced 1 candlepower after it had been in use 8 hours. He did not say lamps did not exist which would fulfil this condition, but he had been unfortunate so far in not discovering one."

At the tests today I propose to show that this lamp will be absolutely extinguished in 6½ per cent. of gas, that it will give a candlepower considerably in excess of any electric lamp on the market, namely, from 1½ to over 2 candles, that it stands a good deal of jerking about without being extinguished; if it is thrown over on to its side it may be picked up in reasonable time without being extinguished, but if left in that position the light will go out before the flames has licked the glass and caused any danger.

I also propose to show that it is a first-class gas detector, and, as stated in the first part of this paper, it has an astonishingly large margin of safety in the presence of gas and coal dust, even when the outer glass is shattered, and that this lamp fails to ignite percentages of gas and coal dust which are readily ignited by an electric lamp.

In conclusion, I might add that on March 29, 1914, Doctor Llewellyn, after testing one of the forms of the combustion tube lamp, states that the lamp gave a candlepower of 1.5, and after burning 6 hours in the pit the candlepower was 1.3, and the light given by the lamp on the floor so excellent that it gave a better light than most of the electric lamps at present on the market, and he agreed that a soft light is better for the eyes of the miner.

In the official government tests on this lamp, the Home-Office officials reported that it gave a candlepower of 1.9 after being lit half an hour, and at the end of 10 consecutive hours' burning that the candlepower was 1.75.

The writer submits that the miner can now be provided with a flame lamp which beats the electric lamp for candlepower, convenience, safety, reliability, cheapness, and what is more important to the miner, possesses true and accurate gas detecting properties.

Coal Mining and Coke Making in Austria

By Ed. Panek

In the Rossitz district, one mine, 1,154 feet above sea level, and 2,086 feet deep, has been worked since 1856. It contains three seams of coal, the most important of which is 21½ feet thick. The coal is got out both by pillar-and-stall and by longwall and shortwall work. It is hauled in cars, and also sent on by conveying belts driven by compressed air. Ventilation is obtained by means of Capell and Guibal fans. At another mine the coal is gotten out by two stages, from longwall and shortwall work, the lower bench being the first removed. This mine and another are served by 300- and 200-horsepower winding engines. The coal is cleaned at the mine by a Baum washer.

Coal dust, which is present in large quantities, is kept down by water spraying, 18,000 feet of pipes being required. Notwithstanding these precautions, there have been five mine fires within the last 10 years, due to the coal dust. There is a rescue station above ground, with a staff of fourteen trained men. In a cross-cut, 2,260 feet from the shaft bottom is a safety chamber, 56 feet long by 6 feet wide, fitted up with compressed air tubes, cutting tools, and a hermetically sealed store of food and water.

The mine manager states that, as the mines are to a certain extent dangerous, ventilation in the working places is carefully watched. The official regulations require the provision of 70 cubic feet of fresh air per man per minute, or 35 cubic feet per ton of coal raised per 24 hours. The training of the men at the rescue station consists not only in succoring the miners in case of accident, but also in repairing the walls in dangerous places, and in parts of the mines walled off through risk of fire. One man thus employed was able to work uninterruptedly for 75 minutes in various postures—lying down, kneeling, etc., without difficulty. An important point is that the men using the breathing apparatus accustom themselves to breathe deep for a few minutes in fresh air before going into the danger zone. This is the chief rescue station, and serves the whole district. The men are paid according to the time that they practice with the apparatus: 20 cents for an hour's work, 41 cents for 1½ hours, etc. All are medically examined within 48 hours after coming up. During the last 10 years the death rate in the district has been five per thousand.

A by-product coking plant was added in 1907, to serve these important mines. The coal yielded 78 per cent. of coke and the time required for coking was 30 to 35 hours. The transportation of the coal to the ovens and the coke to the cooling towers is effected by electrically driven engines, and similar power is used for the tar separators and ammonia washers. There are 35 regenerative by-product ovens, each having a capacity of 8 tons. The gas generated has a heating value of 537 to 560 British thermal units per cubic foot; from 40 to 45 per cent. of this gas is used to heat the ovens, and the remainder is fired under the boilers. For every pound of dry coal fed into the ovens, .6 pound of steam at a pressure of 140 pounds per square inch is obtained. The production of gas is at the rate of 4½ cubic feet per pound of coal. Sixty-nine men are employed, who work 10-hour shifts.

A Fish-Pin Packing Hook

The following useful invention is abstracted from the April issue of the Lehigh Valley Coal Co.'s *Employes' Magazine:*

The careless use of small bars and files for withdrawing packing from boxes has scratched and marred many a plunger and piston rod. The sketch Fig 1 of a packing hook

Fig. 1. Packing Hook

made at the blacksmith shop of Packer No. 2 colliery, Centralia Division, is a suggestion that should eliminate this unnecessary damage. The hook is known as a fish-pin packing hook on account of the application and appearance of its point being similar to an ordinary fishing hook. To remove the packing the point of the hook is pushed along the plunger or piston rod into the packing and given a quarter twist. The hook thus lodges in the packing, which is then easily pulled from the stuffingbox. This hook can be made from a ½" × ¼" spring-steel rod in any desired length. It was gotten up by George W. Gibson, blacksmith at the colliery, and is another illustration of the many handy and useful devices originated by practical and thoughtful blacksmiths at mines.

Bituminous Coal Price

The average value of Pennsylvania bituminous coal at the mines advanced from $1.05 a ton in 1912 to $1.11 in 1913, according to the United States Geological Survey. The average in 1912 was the highest obtained for bituminous coal in Pennsylvania for a period of 30 years, with the exception of the strike years, 1902 and 1903, when because of a scarcity of all kinds of fuel prices were abnormally inflated.

Resins in Coal

The heating value of coal depends on the ingredients it contained as well as the geologic processes to which it has been subjected. Doctor White reports in United States Geological Survey Professional Paper 85, Part E, the almost invariable presence of resins in the brown lignites and in the subbituminous coals, and emphasizes the part played by the resin, which in some coals is very abundant, in contributing to the heating power of these fuels. Most of these coals contain lumps of resin that are visible to the naked eye. The coals mined in some localities contain abundant large lumps of resin, some as large as walnuts. In places the glistening amber-like resin forms a large part of the coal. Beautiful samples of this sort are found in some of the coal beds in the Philippine Islands. The amount of resin in microscopic particles is vastly greater than that in lumps visible to the naked eye. However, all these coals of lignitic and subbituminous ranks, some of which are not far removed or transformed from the original peat stage, are found in rocks that are geologically comparatively recent. On the other hand, resins, especially lump resins, have not definitely been known in the coals buried in the very much older rocks, such as high-grade bituminous, semibituminous, and anthracite coals, and therefore it has been argued that resins were never present in these coals and that they owe their marked difference in quality to correspondingly marked differences in the ingredient vegetal matter from which they were formed, resin producing types having presumably been absent. This rather common belief is totally without basis. Mr. White has not only found lumps of amber-like resin in the bituminous coal of the Paleozoic age in Indiana, Illinois, and Iowa, but he also shows that many of the singular and long ago extinct types of vegetation that grew in the ancient swamps contained this resinouslike substance.

Coal Mining in Yukon Territory

Description of the Tantalus Mines and those of Northern Light, Power & Coal Co.—Quality of Coal and Extent of Development

By Dr. Henry M. Payne*

THE principal coal deposits of the Yukon Territory are Tantalus (Five Fingers Coal Co.), Twelve-Mile Creek, and Coal Creek (Northern Light, Power and Coal Co.). There is a showing of coal at the head of Ruby Creek, back of Haystack Mountain, some 40 miles southwest of Dawson, but the seam is thickly laminated with slate and analyzes 61.64 per cent. ash, which eliminates it from consideration.

The Northern Navigation Co. has opened a semibituminous seam, 8 feet in thickness, on Coal Creek, Alaska, between Circle and Eagle, but which under existing governmental mining regulations in Alaska is undeveloped.

Dawson, the capital of the Yukon Territory, and the entire Klondyke region as well, are therefore dependent upon the three sources mentioned.

The Tantalus mines are located on Lewes River, and the coal is classified by Dr. D. D. Cairnes, of the Canadian Geological Survey, as belonging to the Jura-Cretaceous age. There are several seams separated only by a small thickness of rock, and the present mine, opened in 1912, produces a semibituminous coking coal. All the seams are in a conglomerate formation.

This mine is conveniently located for shipping its product, as shown in Fig. 1, a photograph taken from one of the White Pass steamers descending the Yukon River. Were it not for the large amount of lime and iron it contains, this coal would be the best grade found in the territory. A special washer is being installed by the company to clean this coal.

Fig. 1. Tantalus Mine, Yukon Territory

Fig. 2. No. 2 Seam, N. L. P. & C. Co. White is 6-Inch-Clay Parting

The average analysis of five strip samples is as follows:

	Per Cent.
Fixed carbon	54.44
Moisture	1.32
Volatile combustible matter	19.15
Limestone, $CaCO_3$	4.37
Ferric oxide, Fe_2O_3	3.12
Ash	17.60
	100.00

B. T. U. by formula... 11,551
B. T. U. by calorimeter 11,949

The Twelve-Mile Creek coal shows 7 miles of continuous outcrop, the seam being 6 feet thick with four or five finger partings of slate. Its analysis is as follows:

	Per Cent.
Fixed carbon	31.76
Volatile combustible matter	51.86
Moisture	8.62
Ash	7.76
	100.00

B. T. U., 8,928

The mines of the Northern Light, Power and Coal Co. are about 13 miles from the Yukon River on Sourdough Fork of Coal Creek, Yukon Territory.

The coals are all pronounced lignites of the Tertiary formation, and the various seams are from 3 feet 6 inches to 16 feet 7 inches in thickness.

Mine No. 1 in the seam outcropping on the south side of the creek caught fire in the season of 1911 and being of a very low-grade lignite, full of resin, was abandoned and a new mine opened on the north side of the creek in Sourdough seams Nos. 1 and 2, which are approximately 200 feet below the seam formerly worked.

From all indications, the lower the seams lie and the deeper they are mined, the better the quality of coal produced. No. 1 seam is approached by an incline 200 feet long on a 25-degree slope. At the point where the slope intersects the coal, the seam assumes practically the same dip, gradually flattening out to about 17 degrees, as shown in Fig. 4. About 100 feet beyond the foot of the slope a level tunnel cross-cuts through the 5 feet of intervening gritty soapstone, providing entrance and haulage for the No. 2 seam.

The mines in both seams are operated on the room-and-pillar plan, rooms 50 feet, center to center, and 25 feet wide, leaving 25-foot pillars. Air-courses are 35 feet, center to center, with accompanying entries, leaving 20-foot chain pillars with breakthroughs every 50 feet.

Ventilation is produced by a 2 feet 9 inches Sirocco fan operated at 875 revolutions per minute, requiring 26 horsepower and giving ¾ inch (equals 3.9 pounds) water

*Chief Engineer, Van Gelder, Knoeppel & Young, 55 Liberty Street, New York City.

gauge pressure. At full speed this fan furnishes 22,000 cubic feet of air per minute.

Drainage water is removed by a pump whose capacity is 400 gallons per minute, but whose ordinary duty is 150 gallons per minute.

The mine cars used are of wood, hold ½ ton each, and are pushed to the lieway by the individual miners, from which point they are hauled to the bunkers at the head of the slope by a wire rope.

The maximum dip of the coal near the outcrop being 34 degrees or about 68 per cent. and the minimum at the face of the workings being 17 degrees or about 31 per cent., the rooms are all driven on the pitch and the coal as mined slides by gravity to a chute at the room neck, out of which it is loaded into the mine cars.

The quality of the coal at the face of the workings is superior to any previously exposed, being practically free from resin and resembling a true lignite, with clean fracture and regular structure.

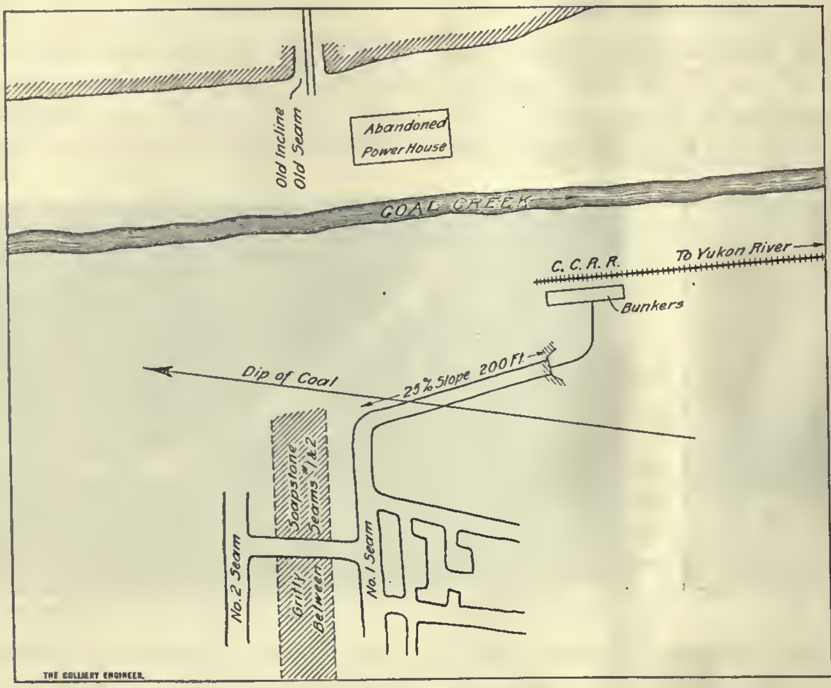


Fig. 3. Plan of Northern Light, Power and Coal Co. Plant

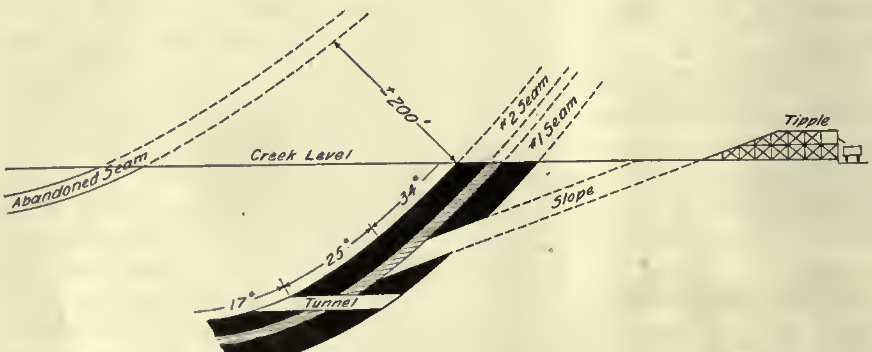


Fig. 4. Cross-Section of Workings

Reference to the accompanying cross-section and the analyses given develops the fact that although No. 1 seam is the easiest to clean for the market, No. 2 seam shows the highest calorific value.

At the present time the output of the mine is 100 tons per day. Sufficient working places are developed, however, to produce 500 tons per day, if a market is available.

After being dumped into the bunkers at the mine, the coal is loaded into railroad cars and hauled 13 miles over the company's railroad to the bunkers at the Yukon River, at which point it is loaded into barges and towed up to Dawson.

The present service is performed by a 14-ton Porter engine and five 10-ton cars. The bunkers at the river hold 600 tons. The barge in use carries 450 tons and is towed by the company's steamer "Lightning."

A test conducted on this steamer, with mixed coal, mine run, from seams Nos. 1 and 2, evaporated 5.35 pounds of water per pound of coal, at 180 pounds pressure, the temperature of feedwater being 190° F.

At the company's boiler plant a similar test evaporated 3.9 pounds of water per pound of coal, with pressure 110 pounds, and feedwater at 60° F.

The specific gravity of the No. 2 coal is 1.99.

The analyses of three samples, all stripped at the face, are given in Table 1.

The 6-inch parting of clay in the No. 2 seam is shown in Fig. 2. A good general idea of the joints characteristic of this coal is obtained from the same figure.

An interesting possibility for this coal is its use for producer-gas purposes. Assuming a standard of 140 B. T. U. per cubic foot of gas, with coal costing $10 per ton at the producer, and labor (Klondyke basis) at 75 cents per hour, the cost of 1,000 cubic feet of gas would be about 13 cents delivered to the compressor.

Table 1

Place	Fixed Carbon	Moisture	Volatile Combustible Matter	Ash	B. T. U.
No. 1 seam (face of counter)	38.26	18.91	28.80	14.03	7,577
No. 2 seam (face of entry)	39.90	19.80	26.90	13.40	9,760
No. 2 seam (face of room)	42.90	19.60	30.00	7.50	10,544

One cord of wood of the grade now in the Dawson market is equivalent to 1 ton of the Coal Creek Y. T. coal when gasified. Figuring on a producer-gas plant efficiency of 65 per cent., one cord of wood is equivalent to 1.54 tons of this coal, when treated in the producer.

From the standard of original cost, therefore, there is little to choose between wood as now used for thawing and power purposes and producer gas.

By-Products from Gas Producers*

The by-products of the gas producer are tar and ammonia, the latter being the most interesting on account of the high price that its sulphate commands. The gas producers that allow a practical recovery of the by-products are the Mond and similar gas generators with zones. The principle of the Mond process is that a large part of the nitrogen of a gaseous fuel in a draft saturated with steam is transformed into ammonia; 75 per cent. of the nitrogen can thus be transformed. In the gas producers with zones, a part of the nitrogen is transformed into ammonia at the time of the distillation. The yield of ammonia in comparison with the nitrogen is from 25 to 30 per cent.

The Mond gas producer, on account of the low temperature at which the fuel is converted into gas, does not agglomerate the coal, and slagging of the ashes does not occur; often one can see gas generators from 3 meters to 3.5 meters in diameter treating 30 tons of fuel a day. The low temperature explains also the long life of these producers.

In the gas producers with zones, the gassification of fuel takes place in a retort that is vertically above the gas generator. The heat necessary to the distillation is furnished by the heated gases that go through the fuel. The mixture of the heating and distillation gases forms a primary gas of which by-products are recovered by the ordinary processes. This gas, which has a calorific power of 900 calories, can be used for heating Martin steel furnaces or for making the secondary gas richer. Steam necessary for the gas generator and for the recovery of the by-products is obtained by means of the heat taken by the secondary gas; it is of about .7 kilogram for each kilogram of coal. At the present time only small sizes of these gas producers are built. In Table No. 1 different gas producers are compared.

The expenses for the first installation amount to $37,500 for five gas producers with rotary grates of a capacity of 15 tons of coal each. The cost reaches $140,000 for four Mond gas producers of a capacity of 20 tons of coal each, and $75,000 for five gas producers with rotary grates of a capacity of 15 tons of coal each. These five gas producers are provided with a device by which they are used as producers with zones. The apparatuses for the recovery of the by-products are included in the expenses of installation for the last two producers.

The Mond gas producers furnish a cubic meter of gas at the lowest price. This comes from the high yield in ammonium sulphate and also from the thoroughness of the chemical reaction which is 77 per cent. while in the gas producers with zones it is only 67 per cent.

In connection with the Martin furnaces, and in a general way, with all the installations in which the gas is used immediately at its exit from the producer, the Mond producers do not offer a decided advantage; on the contrary, the other installations are the most profitable.

Thus an annual saving of $13,400 could be realized by reducing into gas 60 tons of coal in each producer. To this advantage the following may be added:

1. Continual work, for it is not necessary to stop it to clean the conduits as it happens with the heated gases. 2. The temperature of the exchangers does not vary. 3. The composition of the gas is constant. 4. The loss in gas in the sheet-iron conduits is many times less than the loss occurring in the conduits made of fireproof bricks that are necessary in case of heated gases. 5. The gas pressure at the producer can be easily regulated. These advantages cannot be reckoned in figures, but they have a favorable influence on the work of the producers.

The gassification of tar from the gas also increases the calorific power of the gas by combining the heat of the gas and of the tar.

The production of coal in Transvaal, South Africa, for the first 4 months of 1914, was 1,660,306 tons, valued at the pit mouth at £370,630 sterling or $1,803,671.

Table 1. Gas Producers Compared

	Ordinary Gas Producer	Mond'a Gas Producers	Gas Producers with Zone	
			Primary Gas	Secondary Gas
Composition of the gas:				
CO_2, per cent.	4–6	14–16	10–13	.3–5
CO, per cent.	25–28	10–13	3–4	28–30
H_2, per cent.	10–12	22–27	15–20	10–14
CH_4, per cent.	1–2	2–3	10–13	
$CmHn$, per cent.	.2	.2	1.5	
Tar and soot, grams per cubic meter	12–14	8–9	50	10
Ammoniac, grams per cubic meter		2.5–3.5	4–5	-
Vapor, grams per cubic meter	40–50	400–500	300–400	20–30
Amount of gas for each kilogram of coal (normal volume) in 1 cubic meter	3.6	4.2	.7	2.7
Calorific power (normal volume) calories per cubic meter	1,300	1,250	1,900	1,200
Temperature of the gas at the producer, degrees C.	800–900	450–500	100	700–800
Combustible elements of the ashes, per cent.	8–12	30–40	8–12	8–12
Degree of chemical action, per cent.	68	77	67	67
Consumption of steam per kilogram of coal, kilogram	.3	1.7		
Cooling water per ton of coal, cubic meters	6	55	11	11
Yield in sulphate per kilogram of coal, grams		35–40	16–18	16–18
Yield in tar per kilogram of coal, grams		35–40	30–40	30–40
Free heat per kilogram of coal, calories	6,180	5,230	4,820	4,820

*"Recovery of the By-Products of the Gas from Gas Producers."—*Stahl and Eisen*, XXXIII, 1221-1225, 1913. Translated from Revue de Metallurgie for The Colliery Engineer by A. Courtin, B. A. and B. S.

The Firedamp Whistle

By Our Berlin Correspondent

Marsh gas (methane) is quite harmless, so long as its volume in the air of the mine remains below a certain percentage, when however this volume increases to 5½ per cent. the miner's life depends on whether the explosive mixture has an opportunity of igniting. This is why the men in gassy mines should be equipped with some apparatus to detect any rise in the percentage of methane in time to keep away from his place of working any agent of ignition.

The most suitable firedamp test so far available is the flame of the miner's safety lamp which shows, with lowered wick, a cap that in the case of more than 1 per cent. of marsh gas is visible to the skilled eye and exhibits a striking increase in size and distinctness as the explosive mixture is approached.

While Davy's safety lamp is, according to theory, entirely firedamp proof, more than half the firedamp explosions occurring in Prussia are attributed to the gauze safety lamp. This is why the use of portable electric lamps has been prescribed in gassy mines, Davy lamps being only allowed in such mines as firedamp testers. There is a growing tendency to entirely banish any flame from such mines, and to adopt such firedamp distinguishers as will preclude any risk of accidental ignition.

Dr. F. Haber, director of the Emperor William Institute of Physical Chemistry, gives an account of his attempts to produce an absolutely safe and reliable firedamp gauge. Experiments were first made, in conjunction with Doctor Leiser, on a modified Rayleigh interferometer, which both as a stationary instrument and in a portable form, has been adopted in German testing galleries. However, this apparatus, based on variations in the optical density of the atmosphere, is too delicate to be used by miners.

Doctor Haber therefore turned his attention to a gauge appealing to the ear because that member is trained to remarkable sensitiveness in the stillness prevailing below the surface.

The idea of demonstrating to the ear any difference in the chemical composition of gases is by no means a new one. In fact, an old classroom experiment consists in exhibiting before students the difference in pitch of the sounds produced by the same whistle, according as air or lighting gas is used in blowing it. This phenomenon becomes especially striking, when using simultaneously two wind instruments tuned to the same note, but sounded with air and a different gas, respectively.

Doctor Haber's firedamp whistle externally is a smooth, closed, metal cylinder 10 inches long and 2⅓ inches in diameter. This mainly contains two covered whistles tuned to give the same sound (when filled with the same gas) and actuated by the same gas current.

A peculiar feature of the apparatus is that the gas in the tube, on the nature of which depends the pitch of the sound given out by the whistle, is closed by a very thin mica plate against the gas used in blowing it and accordingly remains unaltered for a long time, unless special nozzles are set working.

One of the whistles is filled above ground with pure air unable to mix with the mine atmosphere with which it communicates through a very long and narrow tube. The tube of the other whistle is filled below ground with air from the mine atmosphere, freed by a special cleaning tube from any dust, moisture, and carbonic acid. The apparatus is set working by pulling down the jacket designed as a pump, thus drawing the mine air through the cleanser and the gas whistle, into the pump chamber. A vacuum piston in the center of the apparatus draws the plunger of the pump back on releasing, and drives the sucked-in gas through the pressure regulator to the mouthpieces of the whistles.

If the gas whistle contains, say, 1 per cent. of marsh gas, about two beats per second are perceived. As the percentage of marsh gas rises, the number of beats increases rapidly, and on approaching toward the limit of explosion, a characteristic trill is heard. The ear seizes most readily any acoustic differences, which in the mine, in a straight gallery, are audible with perfect distinctness up to more than 325 feet.

Tests made in the laboratory, as well as in German mines bear out the usefulness of the firedamp whistle.

Barges Propelled by Producer-Gas Engines

In June, 1913, there was launched at New Orleans a self-propelled barge for transporting coal from Alabama to New Orleans. The barge has a length of 220 feet, a beam of 32 feet, and carries about 800 tons of coal. The hull is of steel plate and the freight is carried on deck. The space below decks is given over entirely to the engines, gas producers, auxiliary apparatus, air-tight compartments and quarters for the crew. The six men who operate the barge are supplied with quarters at the bow while the stern contains the power plant consisting of two 75-horsepower Fairbanks-Morse producer-gas engines and a gas producer. There is a 9-horsepower oil engine for driving the lighting dynamo, air compressor for starting the large engines, and other machinery. The producer gas made from coal is not good for engine power unless the hydrocarbons are removed previous to its entering the engine, therefore coke breeze has been adopted in place of anthracite or charcoal from which to manufacture the gas. It would seem from the sucessful operation of these barges that they should find application on rivers as well as canals. The cost of fuel when running on full cargo is about 1 cent for carrying a ton 600 miles. The speed with which they travel and the ease with which they are handled would make the trip from Charleston, W. Va., to New Orleans, about 1,200 miles, a matter of 5 days each way.

Electrical Equipment

Of Sneyd Colliery, Burslem, England—Development from a Lighting Plant to Complete Electric Operation

Written for The Colliery Engineer

Twenty-two years ago the Sneyd Colliery Co., of Burslem, England, installed a small electric plant to light their offices. Eight years later they put in a 50-kilowatt, three-phase, Westinghouse engine generator set for power purposes, operating a 20-horsepower main and tail haulage and a 20-horsepower endless-rope haulage, and a 30-horsepower pump. This was one of the very earliest applications of the three-phase system to collieries in England and it proved so successful the company decided to convert all the haulages in their mines to electric drive.

The plant installed consisted of two 250-kilowatt, Howden high-speed engines, direct coupled to three-phase, 25-cycle, 440-volt alternating-current generators, with exciters separately driven by small steam engines, plenty of space being left for future extensions.

In its four years of service this plant showed so many economies and advantages that it was further enlarged by the installation of a 500-kilowatt turboalternator set. The Rateau turbine is run on exhaust steam from the winding engines, with a thermoaccumulator interposed, and drives a British Westinghouse three-phase, 25-cycle, 440-500-volt turboalternator, with direct-connected exciter, the set operating at 1,500 revolutions per minute.

Sneyd Colliery, Burslem, England

The current is led to the various motors installed on the surface and to the top of the shafts by underground cables, and thence down the shaft to substations.

There are three shafts, known as No. 2, No. 3, and No. 4; the electrical machinery in No. 2 comprising 11 motors, totaling about 380 horsepower, all engaged in haulage and pumping work.

The main haulage to the pit bottom is by engine plane, capable of dealing with six cars per wind, each car carrying 12 hundredweights of coal. These are hauled up a gradient of 1 in 3 for a distance of 100 yards, the motive power being furnished by 100-horsepower, 440-volt, slip-ring motor, running at 475 revolutions per minute, driving by ropes to the haulage pulley, which transmits the power through a friction clutch and helical gearing to the drum, the haulage ropes being of quarter-inch steel wire.

The control for this motor is effected by means of an oil-immersed reversible controller. There are also the following haulage gears in this pit: One 75-horsepower, single-drum gear drawing nine cars up an incline of 1 in 4½. One 75-horsepower endless-rope plant and three 20-horsepower single-drum haulage sets. The latter are semiportable, the gears, motor, controller, and resistance all being fixed to the same bedplate.

The sump water is dealt with by two three-stage pumps, each having a lift of 750 feet driven by a 30-horsepower squirrel-cage motor running at 710 revolutions per minute connected by an 8-inch canvas belt,

one being kept as a spare while the other is in use. Three small pumps, each driven by a 3-horsepower motor, act as auxiliaries.

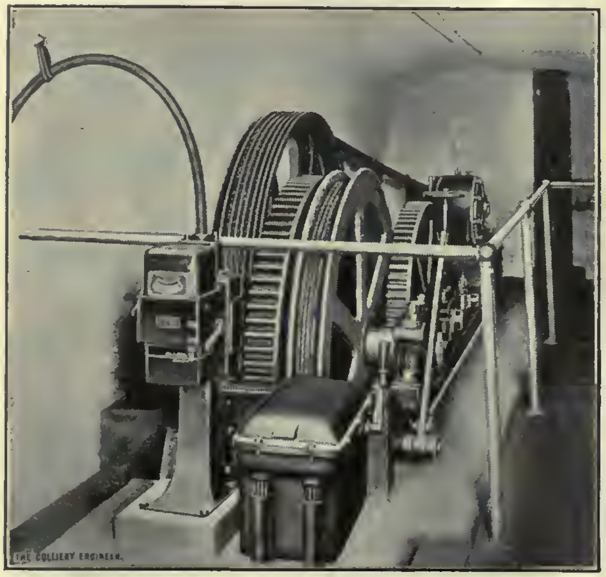
The distribution switchboard supplying these motors is situated at the pit bottom, and current is led by three single conductor cables to busbars at the back of the distribution board. The feeder switches are totally enclosed, automatic, and oil immersed, specially designed for mining work, the necessary meters being mounted within the casing of the switch.

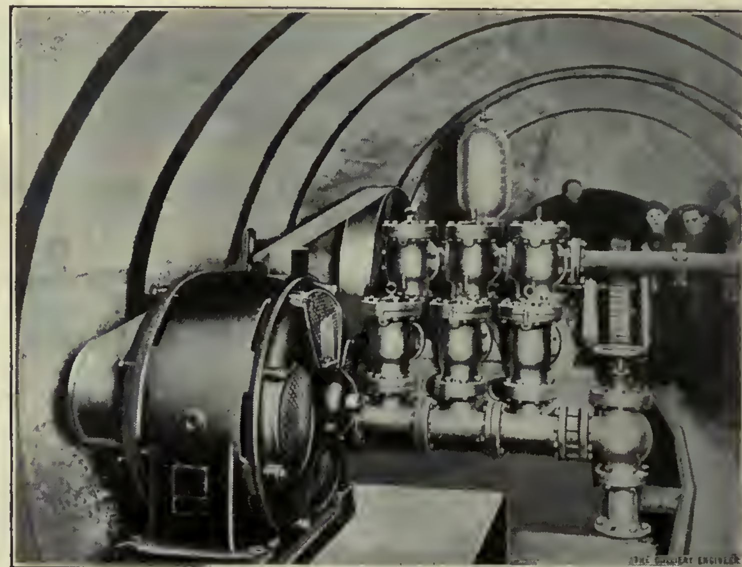
The switch equipment is mounted on two iron pillars, and forms a complete dustproof, waterproof, and more important still in colliery work, gas-tight, ironclad distribution board, from which the current is led to the various motors by armored cables.

A three-stage ram pump having a duty of 200 gallons per minute against a head of 1,200 feet, is driven by means of ropes from a 100-horsepower slip-ring motor. A Riedler pump to which a 75-horsepower motor is attached is provided as a reserve, two other pumps acting as auxiliaries.

In No. 4 mine there are two methods of rope haulage, namely, main and tail, and endless rope, which differ from the single drum haulage employed in No. 2 and No. 3.

The single drum or engine plane haulage consists of a single drum winding a single rope, and, therefore, the gradient must be steep enough to allow the cars to draw the rope back by gravity; in the main and tail-systems the main rope hauls the full cars and the tail-rope takes back the empties. In No. 4 mine there are two of these haulages, both driven by 75-horsepower motors, each capable of dealing with 30 cars at an average speed of 5 miles per hour.


20-Horsepower Motor, Driving Endless-Rope Haulage, Sneyd Colliery


30-Horsepower Motor, Driving 3-Plunger Pump, Sneyd Colliery

In the endless-rope haulage the rope is passed two or three times round a pulley, and then round a guide wheel at each end of the road, the cars being affixed to the ropes by clips. It will be seen that to allow of the use of this haulage the road must be wide enough to allow two cars to pass each other at any point on the route. In this particular case, a 20-horsepower squirrel-cage motor drives the haulage pulley by ropes, thence by pinion and spur wheel to the pulley. The switch gear operating the motor is similar to those used on the distributing board, and an oil-immersed controller. All the haulages in the mine are fitted with strong band brakes. There are also two single-drum haulages in this mine, driven by 20-horsepower slip-ring motors, with tramway controllers that deal with four cars on a 1 in 4½ gradient.

Two 5-horsepower squirrel-cage motors operate creepers, one raising loaded cars and the other empty cars, both working at the pit bottom. One motor of 50 horsepower drives by means of a belt a two-stage air compressor, the air being used for percussive drills, and two small haulage winches.

Hydraulic rams are used to push the full cars into the cage and at the same time push the empties off, a three-stage pump driven by a 10-horsepower motor supplying the water pressure. This is a most useful device and saves a great amount of time and labor in getting the coal to the surface. Total horsepower of the 10 motors working in this pit is 300.

The four-deck cages are capable of carrying 8 cars of coal per wind, and are operated by 2,000-horsepower steam engines working at 90 pounds steam pressure.

On arriving at the surface, electricity is again requisitioned to convey the coal to the screens and also in the actual operation of screening. At the shaft collar there is a 20-horsepower motor driving a creeper by pinion and spur wheel, which is capable of pulling the loaded wagons up the incline to the screen, into which the coal is tipped by power driven tipplers.

The screens are large, rectangular sieves, which are placed on a slant and shaken by eccentrics, the latter being driven by a 150-horsepower motor.

As the coal drops through the screens, it is conveyed to the chutes on belts operated by five 5-horsepower motors; the refuse, picked off by boys, is carried away by a small conveyer belt known as the refuse belt. A 10-horsepower motor controls the hoisting gear for raising the jib ends of the loading belt, to minimize the breakage of coal falling from the belt ends.

An interesting feature of the screens is the installation of Westinghouse Cooper-Hewitt mercury vapor lamps, the light from which is found to be admirably suited for coal picking.

A fan driven by a 20-horsepower motor extracts most of the dust and delivers it in a "Maxaner" apparatus, where it is mixed with water and allowed to settle, the sediment being afterwards dried and burnt in the boiler fires.

In the machine shop a 3-horsepower squirrel-cage motor drives line shafting from which three lathes, a radial drill and drilling machine, and a 6 ft. × 2 ft. planer are operated, while in the carpenter shop a 20-horsepower motor drives a 4-foot circular saw.

Electric motors are also used to operate the blacksmith's shop and the crane, the latter being worked by two motors, a 20-horsepower motor for hoisting and a 6-horsepower, 110-volt, direct-current motor for slewing the crane.

There are at present 53 motors installed, totaling 1,440 horsepower, varying in size from a small 3-horsepower pump motor to a 150-horsepower motor that is used to drive the screens.

The gradual extension of this plant from a small lighting set to an installation with a 1,000-kilowatt output, is conclusive proof of the efficiency and economy with which electricity meets the varied conditions that are experienced in colliery work.

Turbine-Driven Centrifugal Mining Pumps

Among the many uses to which turbine-driven centrifugal pumps are now being put, the most important is the field of mining.

The qualities peculiar to pumping outfits of this kind are simplicity, durability, compactness, and efficiency. Space considerations are naturally of the utmost importance in underground work and the very small dimensions of high-powered centrifugal pumps would recommend their use in many instances without very deep inquiry into their other virtues.

To those unfamiliar with the modern turbine and centrifugal pump, the speed and power of these machines is almost incredible.

For example, a five-stage centrifugal pump direct-connected to a single-stage steam turbine, stands about 48 inches high and is not over 10 feet in length, yet the combination has a capacity of 1,000 gallons of water per minute against an average discharge pressure of 270 pounds. The small size and simple construction of this combination compared with the complication and great weight of the reciprocating pump for the same service is very noticeable. For smaller discharge heads the number of stages of the pump would, of course, be reduced, it being general practice to carry up to 50 pounds with a single stage and above that pressure to use the multistage principle. As there are no valves whatever in this kind of pump and the only moving element is the rotor, the depreciation is small and furthermore the effectiveness of the pump is certain to last as long as the pump itself.

For handling the water usually found in mines the valveless feature of the centrifugal pump makes it extremely valuable. Nearly all mine waters are impregnated either with saline or acid solutions or contain silt or gravel, any of which agencies rapidly destroy the valves of a plunger pump. If the centrifugal's rotor is constructed of bronze, as is usually the case where the pump is to be subjected to use of this character, the wear will amount to very little. As a means of propulsion for centrifugals no machine has yet been devised which fills the bill as completely as does the small steam turbine. Because of its superior range of speed, it is possible to get a unit of very much smaller diameter to do the same work as a much larger pump driven by a reciprocating engine.

In simplicity the turbine rivals the pump, there being a single row of buckets on the rotor. This single-stage feature necessarily reduces complications. In order that the speed shall not be abnormal, however, the steam in the course of its expansion is forced to traverse the buckets several times, each time being redirected onto the wheel through the return passage in the casing until the entire energy is dissipated. In this way the wheel receives the energy of the steam in successive stages and therefore the peripheral speeds are much lower than would be the case if the steam impinged upon the wheel at once. All the moving parts are inside a stout, cast-iron casing excepting the connections from the governor on the end of the shaft to the governor valve on the inlet pipe. These are made of very heavy construction and are carried close to the journal and casing where there is but little danger of their being dislodged. In case of trouble, however, the design provides for instant closing of the governor valve.

For most underground mine work the pumps would of necessity be of the multi-stage type and in a sufficiently deep mine it might be advisable to set the pumps themselves in successive stages. In either case, the arguments for the steam turbine as the means of propulsion are equally fundamental, and the greatest argument in favor of both machines that it is almost impossible to get them out of order should certainly prove conclusive for their employment in mining work.

Miners' Baths

Experience in the Construction and Use of Bath House at the Collieries in England and on the Continent

By H. F. Bulman and W. B. Wilson*

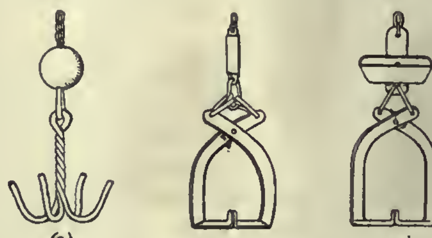
OF ALL the changes made by the new Coal Mines Act none, perhaps, has attracted more general interest than the proposal to provide facilities for miners to wash themselves and to change and dry their clothes at the pit head. This provision seems likely to be a benefit to the miner in promoting not only his own personal comfort and cleanliness, but also that of his home, and in relieving his womenfolk of much of their present household work. There is no doubt but that many miners dislike the idea, but experience in other countries shows that when the miner becomes accustomed to changing his clothes and washing at the mine he would strongly object to revert to the old custom.

In Belgium, April, 1910, of 278 collieries at work, 42, employing 21,560 men underground, were provided with spray baths of modern construction. The workmen quickly grasped the benefits which these baths procured for them, and of these 21,560 men, 16,650, or 77.3 per cent., voluntarily made use of the baths in 1909.

In the north of France, where the use of baths is also voluntary, the experience is similar; and in Westphalia, where the measure was made compulsory at all collieries by a decree dated March 12, 1900, it is carried out to the mutual satisfaction and approval of both employers and workmen.

The information embodied in the present paper was gathered by the authors in May, 1911, in Westphalia, Belgium, and the north of France.

Washing Apparatus.—The actual washing arrangement always takes the form of an overhead shower of warm water from a rose about 7 inches in diameter, placed 7 feet or 8 feet above the floor. Under such a shower the dirtiest man, with the aid of a piece of soap, can clean himself within 10 minutes. The shower bath affords a rapid, effective, and pleasant method of washing all over, and the water falling on the floor is removed by a simple system of drainage; as the pipes and rose are overhead they occupy no floor space, and comparatively little room. The bathing place can be cleaned readily with a stream from a hose.



(a) (b) (c)

Fig. 1

The amount of water required for each bather is comparatively small. Mine Inspector Kuss states that for collieries in Belgium it averages 6½ gallons per man per bath. The figures given at some of the collieries visited were higher. At one colliery in Belgium 7.7 gallons were allowed, while one in the Pas de Calais allowed 8.8 gallons to each man.

In Belgium and France each shower is installed in a separate booth, in order to insure privacy to the bather, and in addition to the main controlling taps there is a separate tap in each booth for the use of the bather. In Germany the men wash all together, and it is not unusual to see one man scrubbing another's back. The orderly and rapid way in which a large shift of some hundreds of men get through the business of bathing is remarkable. At some German collieries the boys are housed in a separate part of the building, but there are not separate booths for each bather, and the water supply is controlled by the attendant. As eight or ten of the showers are controlled by one tap, they must all be kept running, or all stopped together, and this probably tends to a greater consumption of water than would be the case if each shower were separately controlled. The average daily consumption of water at bathing establishments in Westphalia, including the officials' baths and the water used in cleaning up the place, was 33 gallons per man.

The water heating apparatus is placed near the controlling taps at one end of the building, so that one attendant can manage everything. The water is generally heated by exhaust steam from the colliery engines, though in some cases live steam is employed. For mixing the steam and water together, injectors are sometimes employed, and in some instances this is effected by bringing together the steam and water in an old boiler or other similar receptacle, in the same way as boiler feedwater is often heated. The heated water is cooled down to the desired temperature, usually 98° to 100° F., by an admixture of cold water from a separate tap.

The ordinary method of storing and drying clothes is by suspending them from hooks in the upper part of the building, thus exposing them to the drying effect of the heated air. For this purpose the building is spacious with side walls usually 20 feet to 30 feet in height, the roof sloping upwards to a central ventilator running the whole length of the building. In cold weather they are heated by steam radiators to a temperature of about 70° F.

Different forms of hangers are in use, the most common consisting of three or four hooks projecting radially from a central vertical stem [Fig. 1, (*a*)], while another is in the form of a stirrup opening in the center [Fig. 1 (*b*)]. In Westphalia a little metal dish to hold a piece of soap is added, usually fixed above the hooks [Fig. 1 (*c*)]. Each man provides his own soap and towel.

*Read N. E. Inst. Minn. and Mech. Engineers.

Where there are separate bathing booths, as in Belgium, the soap dish is placed in the booth. To each hanger is attached a metal plate bearing a number, and every man using the bathing establishment appropriates one of them, and thus knows his hanger by its number. As many hangers as there are men to bathe are provided. Each hanger is hung at the end of a small linked chain, about ¼ inch across, which runs easily round small pulleys.

At the girders are fixed a series of light steel beams 3 inches or 4 inches wide, horizontally spaced at intervals of about 1 foot 4 inches apart, and carrying small pulleys. From each hanger the chain rises to a pulley, around which it passes, thence traveling to a second overhead pulley, from which it descends, to be tethered to a metal pin projecting from a fixed stand on the floor of the building. Each pin has a metal plate bearing a number corresponding to the number of its hanger. The length of chain must be sufficient to extend from the pin around the two overhead pulleys down to the hanger when it is lowered to allow the man to get at his clothes. When the bundle of clothes is raised, which is effected by pulling on the chain at the pin, there is some length of loose chain to dispose of, and there must also be some means of fastening the chain. This is done by attaching to the chain at the right point, say 8 feet from its end, or at whatever height the hanger is to be raised, a ring which is put on to the pin, and this holds the chain with its hanger in the desired position. The loose chain is allowed to hang in folds from the pin, which is fixed at a height of 4 feet or 5 feet from the floor, while sometimes a lower row of pins is provided, and the loose chain looped round the two.

The newest and neatest arrangement consists of a metal box, about 10 inches high, 4 inches wide, and 2 inches in outside dimensions. The loose chain is lowered into this box and is held by a circular stud fixed to the chain at the required point, the stud being passed under a catch on the top of the box, which holds it safely. The pins may be made with eyeholes at their outer ends, so as to carry a padlock, and the boxes just described are provided with a similar arrangement. In most establishments very few padlocks were in use, and none in some of them, showing that they were not necessary, and that men may be trusted, as one would expect, not to meddle with each other's clothes.*

The position of the hangers is determined by the position of the pin stands, and of the overhead pulleys; where the stands are set against the sides of the building, with their backs, so to speak, to the wall, the pins and hangers must be all on one side. It seems better to place them so that each stand has its set of hangers extending from it on either side. Each adjacent chain is carried 16 inches, or whatever is the distance between the overhead beams carrying the pulleys, further or shorter than its neighbor, so that the bundles of clothes are spaced evenly. The amount of vacant space around each bundle depends upon the distances between the pulleys and the relative height to which they are raised.

In Westphalia a fair allowance of superficial space is considered to be 20 inches to each hanger—and it should also be observed that the hangers are not all suspended at the same level. In addition, there are vacant spaces around each set of hangers, so that there is room for air-currents to play about the clothes and to dry them. It is the rule that every man must take away his clothes at the week end. Anything that is left behind is sent to the boiler fires, and a thorough cleansing of the whole building is carried out during the week end. It is, of course, open to any man to take away any of his clothes and bring others whenever he likes.

Fig. 2. Hangers in Bath House

In the design of the buildings the chief points to be kept in mind are cleanliness, ventilation, light, and room. The floor and the inside walls, to a height of 7 feet or so, should be of some material that can be easily washed clean by water from a hose, and nothing is better for this purpose than glazed bricks or tiles. Crannies and corners where dirt can accumulate should be avoided as much as possible, and in the upper parts of the walls there should be ample window space for light and ventilation. In the best designs the roof slopes upwards from the side walls to a central raised structure of glass, with ven-

*In the United States men buy their own locks.

tilators running the whole length of the building as shown in Fig. 3.* this ensuring thorough ventilation and light. For artificial lighting, electricity is, of course, the best medium.

At New Ickern colliery, not very far from Dortmund, a bath house,

Fig. 3. Showing Ventilating Construction

just completed, provides for 2,500 men. It is built mainly of concrete, and cost, without fittings, $15,000. The water pipes and roses are placed in two side aisles, or wings, running upon either side and the full length of the building, each side aisle or wing being separated from the main central portion by a well with numerous archways. The central portion is devoted to drying and pressing purposes, and contains the pin stands and the clothes hangers.

At Rhein-Preussen colliery the building is 180 ft. × 84 ft., including the aisles, which are each about 12 feet wide. In the side aisles are fixed 144 showers, arranged mostly in sets of eight. To each set of eight showers a foot-rest is provided, about 1 foot in height and 6 feet in length, to assist the men in washing. This foot-rest is made of wood at Rhein-Preussen; but at Ickern it is made of concrete. In the main building, which has an area of 1,200 square yards, there are twelve pin stands, placed parallel to the width of the building, six on each side, each stand occupying a length of 24 feet. They each consist of five stout metal posts, 5 feet high, to which are fastened metal bars about 4 inches wide, one on either side, to hold the pins. There is a lower set of bars and pins, to allow the loose chain to be lapped around the upper and lower pins rather than to hang in folds. The posts also carry projecting brackets, on which are fastened wooden planks, forming a seat on either side, similar to that shown in Fig. 2.*

The authors were informed that there was accommodation for 4,000 men, divided over three shifts. This allows for the future development of the colliery. The total number of underground workmen employed at present is 2,400, the greatest number coming out in one shift being 985, and the average daily output of coal was 2,000 tons. The actual time occupied in washing and dressing was about 15 to 20 minutes per man, the time under the shower being not more than 10 minutes.

The building is heated with steam radiators to a temperature of about 85° F. A covered way connects the building with the shaft collar, so that the men are not exposed to the weather until they have washed and changed their clothes. Adjoining the bathing hall is a waiting room.

At the Quesnoy pit, of the Bois du Lac Co., Belgium, the bathing installation comprises two buildings, one for washing and the other for dressing, communicating with each other by a short passage. About 500 men use the establishment, and the bathing hall is 69 feet long, 46 feet wide, and 23 feet high. There are 80 showers, arranged, as shown in Fig. 4, in sets of ten, from eight branch pipes, each pipe being about 15 feet in length, and carried out from the side walls in a direction parallel to the width of the building. From the branch pipe, five short pipes, each about 2 feet in length, project at right angles on either side, terminating in the roses for the showers. The 80 bath cabinets are made of painted sheet iron, and are grouped in sets of ten, one to each shower. The dressing hall is 75 feet long, 46 feet wide, and 41 feet high. The hanger hooks are fixed along the side walls, and it is considered that there is room for 1,000. Twelve wooden benches are arranged about the hall.

Mr. Kuss gives the cost of this installation as follows:

	Dressing Hall	Washing Hall	Total
Ground....	$ 357	$ 357	$ 714
Buildings ..	5,200	5,120	10,320
Fittings ...	1,415	3,510	4,925
	$6,972	$8,987	$15,959

This total sum of $15,959 is the first cost of this installation of 80 showers and 800 hangers, equal to about $20 per hanger or per man using the baths. Mr. Kuss considers that from $4 to $4.50 per hanger is the average cost of a new installation of any importance in Belgium.

At one of the new collieries, Fosse No. 13 of the Lens company, Pas-de-Calais, there is a fine brick bath house well lighted and ventilated by large glass windows running continuously along its two sides in the upper half of the walls. It is 78.7 feet long, 36 feet wide, and 21 feet high to the top of the wall, the total height to the roof ridge being

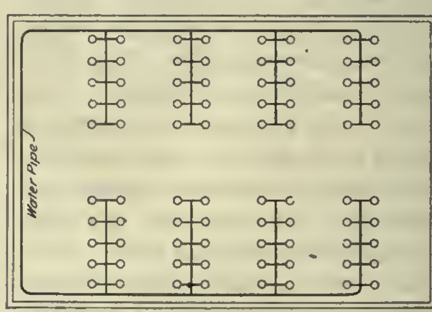


Fig. 4

33 feet. The building provides for 650 men in two shifts, there being 650 hangers and 56 showers; the latter being placed around the walls

*Figs. 2 and 3 are views of bath houses at American coal mines, showing arrangements similar to those described.—Editor.

of the building, with a separate cabinet for each shower.

The bath rooms, lined with white glazed bricks, are 39½ feet wide, 5 feet long, and 6¼ feet high, with no separate compartment. The entrance to each room is provided with a wooden door, arranged so as to turn easily around its central vertical axis. To one side of the door are fixed four hooks for hanging clothes, which can thus be turned outside to avoid getting them wet when the bather is washing, and inside when he wants them. The central portion of the building is used for changing the upper garments, and for keeping and drying the clothes that are left, in the manner already described. It is evident that the number of showers provided must depend upon the largest number of men coming out in one shift, and on the time which they take to come out, as a man cannot be expected to wait for his bath very long. The number of hangers must equal the total of men using the establishment.

DISCUSSION

Professor Louis said that the authors mentioned that the washing arrangement always took the form of a fine shower or spray. It might be interesting to point out that that was not the original form. At first, in Germany, plunge baths were used, but it was found that contagious diseases, particularly of the eye, were communicated by this means, and therefore the law made the use of shower baths compulsory in Germany. In one or two collieries in Westphalia, there were seats made of enameled cast iron or concrete in front of the sprays, so that the men could sit down when washing. Another point was in regard to very few padlocks being in use. He had been told that they had a great deal of trouble in Westphalia owing to thieving going on, so that they instituted a rule that every chain must be padlocked, but that each miner must provide his own padlock and key. Finally, he would like to draw attention to the fact that in all the metal mines in this country it had been the custom for a great number of years to have what was called a "dry." In all the Cornish mines, and in most of the lead mines, and ironstone mines, and, indeed, he thought all the mines under the Metalliferous Mines Act, a "dry" was provided in which the man changed his clothing.

Mr. C. Herman Merivale said one of the difficulties was to ensure privacy for the men. They would not wash in a crowd, they would want privacy, and that meant partitions. Tiles were made now with locking joints, very narrow, not more than an inch wide, and there would be no difficulty in making partitions in tile slung from wire rods, which would occupy little space, and that would overcome the difficulty of considerable extra expense in making partitions. He had tried to get the men at Middleton to adopt the bath system, and had offered them partitions, but they objected to the whole thing.

Mr. J. H. Mericale indorsed what Professor Louis had said. His experience of baths went back 40 years. In Belgium they did not use the spray at all; each man had a little separate bath. The last time he had to speak on this subject was in a different atmosphere, where they were strictly commercial and that might be his excuse for saying he was the only man who approved of compulsory baths. Looking in the direction in which things were trending, he was inclined to think that they would have to supply their men with baths; for many reasons, he thought, it would be an excellent thing if they did, and unless they made such arrangements as had been described they would have to put baths in the workmen's houses. His experience corresponded with what the paper said as regards the cost—$20 to $25 per man employed—but he did not think they could put baths into the existing houses at anything like that figure. There were two other reasons which inclined him to be favorable to baths; one was that it made matters much more comfortable and convenient for the women, and, again, they all knew the miner, with very few exceptions had a longer expectation of life than any other workman, the reason, he believed, being that he had plenty of work, plenty of food, and plenty of washing. But he suffered more than others from bronchial troubles, and he believed that that was very largely due to standing about after coming out of the mine in a heated condition.

The president (Mr. M. W. Parrington) said that one point which struck him was as to the nature of the water. One might wash fairly clean with 6½ gallons of Newcastle water, but he was doubtful if they could accomplish that with 6½ or even 8½ gallons of limestone water in Durham.

Engineering and Coal Mining Journals

*By Neil Robinson**

At our meeting in Charleston, December last, the greater part of our time was given to the discussion of general subjects that were of importance to all of the industries within the borders of our state. We did not specialize on coal alone but included able addresses on "Sanitation," the "Panama Canal," "Prohibition," the "Creation of Public Sentiment," illustrated views of Alaska, and various other topics that were of such universal interest that they were published in full in papers as far west as California and Oregon, Canada in the North and Maine in the East.

The present session is to be devoted exclusively to the consideration of every-day, practical, and technical coal mining methods. Our good secretary has arranged the formal program that is before you and has paved the way for an expansion of the field through the question box. A number of our members have expressed great pleasure in having this opportunity to ask questions and secure information in regard to operating details with

*President W. Va. Mining Institute, Charleston, W. Va.

which they are immediately concerned.

Naturally, and logically, this has brought to my mind the greatest question box in the world—the queries columns of the engineering and mining journals of the country through which every inquiry can be answered, and information of inestimable value secured by any one who will seek it.

The value of the mining journal to the superintendent, mine foreman, and every ambitious employe of a mine is simply amazing; and the members of our Institute can perform no greater service to the industry they represent than by encouraging—I may almost say coercing—the men under their direction to subscribe for and read and study at least one of the many good papers available.

We would not care to employ a lawyer who knew it all and never kept in pace with new laws and new decisions; nor would we knowingly entrust a doctor with the care of our physical ailments if advised that he never read a medical journal and only had vague hearsay knowledge of new medicines and new treatments.

If we apply this test to the men who are to pass upon points of law and those who are to treat the ills of an individual, how much more rigidly should we apply it to the men who are responsible for hundreds of lives in the depths of the mines. No man can keep abreast of the times who fails to profit by the wonderful stores of knowledge presented every week and every month in the journals that specialize on coal and coal mining. The advertising columns, with illustrated descriptions of new machinery, have a value almost equal to the literature in the body of the paper and we can truly say that a good journal will give us a profit from cover to cover. The fine periodicals now at our disposal will carry to every mining village in our state quick knowledge of progressive methods wherever they may be adopted, whether in our own country, Germany, Belgium, Great Britain, or far-away Australia.

My message is brief but it is very important. Let me urge with all possible earnestness that every member of this Institute shall lend his best efforts to the dissemination of the wonderful stores of information contained in the trade papers, that the men connected with the mines in West Virginia may become the best posted men in the mining world.

Mine-Car Bumper

Owing to the destruction of so many mine cars caused by their bumping together frequently, the Connell Anthracite Mining Co., at

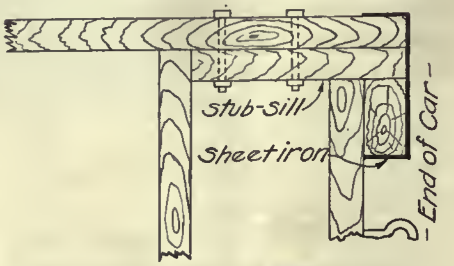


Fig. 1. Mine-Car Bumper

New Bernice, Pa., mine, adopted the stub sill in the construction of its cars. The stub sill like the side sill of the car is 4 in. × 6 in. and the new arrangement distributes the shock through the block to the first crosspiece, through the stub sill to the second crosspiece and along the length of the car through the side sill. The arrangement is shown in Fig. 1, which is a plan of one car end corner.

Practice First Aid

Dr. George Halberstadt, chief surgeon and in charge of the first-aid work of the Philadelphia & Reading Coal and Iron Co., said recently in addressing some of the teams: "Not one of you would dream of sitting down to dinner under a loose ceiling that looked as if it were about to fall, and yet some deliberately work for 5 hours a day under a loose roof in the mines."

One of the many results of the past year's work of the first-aid movement has been the adoption of broad leather washers for use on hand drills. These have prevented many fingers from being crushed.

Disadvantages of Short Fuse

The object of using fuse for igniting explosives is to allow the charge to be thoroughly tamped and confined, and after lighting the exposed end to allow the miner ample time to get to a place of safety before the charge explodes. To fulfil its whole object, the fuse must extend from the charge far enough out of the drill hole to allow time for the blaster to "take cover" after lighting the fuse. The fuse must extend to the collar so that the tamping may be done thoroughly, otherwise the whole of the explosive power is not realized and money value in explosive is thrown away.

Some miners cut the fuse attached to the cartridge so that it is a foot long or less, then light the fuse, and while it is sputtering, ram the cartridge into the hole, and run. They may, sometimes, throw in a light tamping, but their time is too short to tamp the charge as the locality is distinctly unhealthy for the time being.

Why do they do it? To save fuse, which costs from a third of a cent to a cent a foot.

By using a foot of fuse instead of 2 or 4 feet they save from 1 to 3 cents worth of fuse, but they waste as much or more than this, because from lack of proper tamping only a part of the explosive power of the dynamite is realized. In the open, a foot of American fuse takes about 30 seconds to burn, but in the bore hole, even when tamped hurriedly and incompletely, it is liable to burn faster.

What good will it do the miner to save a few cents a day on fuse while he is wasting several cents a day on dynamite?

This practice of using "short" fuse is wasteful of explosives, is dangerous, and in the long run will injure or kill the miner.—*Dupont Magazine.*

Miners and Mining

Abstract of a Speech by T. A. Rickard at the Fiftieth Anniversary of the School of Mines, Columbia University

Written for The Colliery Engineer

THE following is an abstract of a speech by Mr. T. A. Rickard, of the Royal School of Mines, London, Eng., at the fiftieth anniversary of the School of Mines, Columbia University, in the gymnasium, May 29, 1914. Mr. Rickard said:

"It is a common saying that agriculture and mining are the two basic industries. When man rose above the brutish individualism of his primordial state and began to develop the social instinct, he turned to the soil, in order to win food for his family. He paused in his migration, the soil held him; it gave root to his rudimentary community; it gave him the chance to enlarge his energies. His tracks became highways; his rivers, avenues of trade; and as his traffic expanded, so his imagination widened, until, out of the crudities of communal development grew the complexities of civilization.

"But the nomadic habit lingered; the spirit of the hunter survived in man; a wanderer and a wonderer he stood beneath the starry dome of the forest arch not knowing whether he were the guest or a captive in the domain of Nature. The hills beckoned; the seas called; the more venturesome left the tents of the tribe in search of material wherewith to fashion their implements. They sought iron for weapons, copper for tools, gold for ornament, and found them in various guise in the earth under their feet. They became miners. To those who delved successfully came power. Throughout the ages the more energetic and venturous broke from the plough and forsook the cattle in order to explore and to exploit. They brought the metals from which the artificers fashioned engines of power and machines of intelligence. They won the materials for a social structure that, based on stone and built in iron and copper, soared in many storied tracery of steel to towers radiant with light and vibrant to the sky—towers so far above the common ground that man almost forgot his lowly origin and claimed kinship with the stars.

"The story of mineral exploration and racial migration is peculiarly the heritage of our people, the Anglo-Celts. It is the *motif* that runs through the drama of English and American history, more particularly during the last hundred years. Even in its barest outlines it serves to suggest that the miner is the pioneer of industry and the herald of empire.

"The first social organizations around the shores of the Mediterranean sent their prospectors to the hinterlands of Europe, Asia, and Africa. The gold of Ophir, the copper of Sinai, the silver of Laurium, were part of the web and woof of those early civilizations. The mines of Iberia gave Hannibal the sinews of war against Rome, and the gold of Davia strengthened the resources of Rome under Trajan. But the greatest adventure was that of the Phœnicians who passed through the Pillars of Hercules into the western ocean in order to reach the far Cassitorides, the tin islands that in turn were to produce those Cornishmen to whom the world is one big mine. After Carthage and Rome, in turn, had been overthrown, the mining industries of the known world were disorganized. Desultory operations persisted in Hungary, Spain, and Saxony, but the Middle Ages to the miner were as dark below ground as above. Even the discovery of America, which marked the beginning of a new world movement, was not connected with a real advance in mineral exploitation, although associated with the winning of gold and silver. It is true, the wave of Spanish conquest broke over the American continent, penetrating the treasure vaults of Mexico and Peru. But the Spaniard devastated, he did not develop. He gathered the harvest that the patient Indian has secured by the laborious toil of centuries. Cortez and Pizzarro were filibusters, not explorers; they were pirates, not miners. The conquistadores were not pioneers of industry; behind them arose the smoke of ruin and the dust of destruction. Even the great sea captains of Elizabeth were but the sequel to an epoch of spoliation. After them, and in their wake, across the sea, came the men who from Cornwall and Devon, from Saxony, and the Harz, brought the technique of mining to the new world, applying it peacefully to the mineral development of Mexico, Peru, and Chile, all along the regions previously ravaged by European freebooters.

"But the great era of mineral exploration came with the discovery of gold in California. It was the prelude to a world-wide migration, an enormous expansion of trade, a tremendous advance in the arts of life, and the spread of industry to the waste places of the earth.

"The color of energy began to tint the blank spaces on the map. The western half of the North American continent, all of Australia, the southern half of Africa, the northern half of Asia, were invaded, penetrated, and explored by those in search of gold, of other metals, and as each successive mineral discovery was made by the miner he called upon his fellows to come and take a hand in the good work. He was the scout far ahead of an army of development. Trade follows the flag, it is true, but the flag follows the pick."

Mr. Rickard then told of the finding of gold in California by James W. Marshall on January 24, 1848, and of the sudden rush of the

gold seekers to the Pacific Coast which is so well known in the history of California and which resulted in the production of $81,-294,700 in gold in 1851, giving details of the subsequent history of the industry. Among those who were first in those fields was E. H. Hargraves, an Australian, who was led by the analogy of geologic conditions to those in his own country to suspect the occurrence of gold there, and he returned to his home in New South Wales, where on April 3, 1851, he announced the discovery of gold in Australia. The rush to those gold fields was great and in 1853 the gold production there was $54,882,000. The first diamond was found in South Africa, he said, in March, 1869, by a Griqua shepherd who sold the stone, weighing 83½ carats for 500 sheep, 10 oxen, and a horse, and this led to the rush to the banks of the Orange River. The subsequent history of the De Beers and Kimberly mines, and the advent and careers of Cecil John Rhodes and Barney Barnato were well told, and Mr. Rickard then went on to tell of the finding of gold in 1884 in the De Kaap region and the subsequent discoveries in other regions which led up to the exploitation of the Rand, beginning in 1886, and the production in the next 25 years of more than $1,500,000,000 from the gold fields there. The West African fields—the Gold Coast—had, he said, averaged $1,750,000 per annum during the first half of the nineteenth century, but real mining there did not begin until 1880, when a Frenchman, Marie Joseph Bonnat, who had been on the Coast for a number of years, returned to Paris and formed a company which did not prosper, but which resulted in the finding of tin which has long been a thriving industry there. Then he told the story of the Yukon, beginning with 1880 and leading up to the rush to the Klondyke in 1897. The output from that region, he said, in 1898 was $10,000,000, with a total output to date of $150,000,000. After speaking of the great work of prospectors in the development of the countries they visited, he concluded by saying:

"After the prospector has come the mining engineer. The scout has gone in advance of the captain of industry. Those of you that have crossed the range in winter know how the leader breaks the trail by leaving footprints into which his followers tread, step by step, greatly to the safety and ease of their travel. That is what the mineral explorer has done for the mining engineer. That is what the mining engineer has done for those behind him. Some of you have been prospectors as well as engineers.

"Have you known the Great White silence, not a snow gemmed twig aquiver?
"Have you broken trail on snowshoes; mushed your huskies up the river?
"Have you marked the map's void spaces,
"Felt the savage strength of brute in every thew?

"Again, I ask you to recall how you threaded the pathless forest on your way to examine a new mineral discovery. On the trees at intervals you have seen that the bark was chipped. The trail has been 'blazed' by the prospector, making it easy for you and others to follow. That is what the miner has done in a larger way for civilization. He has done it with geographical exuberance and equatorial amplitude. From 'the stark and sullen solitudes that sentinel the Pole' to the 'steaming stillness of the orchid-scented glade' in the Tropics, he has left his mark. You know that. No need for the prospector to complain to you, like Kipling's explorer:

"Well I know who'll take the credit: all the clever chaps that followed—
"Came a dozen men together—never knew my desert fears;
"Tracked me by the camps I'd quitted, used the water holes I'd hollowed.
"They'll go back and do the talking. They'll be called the pioneers!

"No; not by the men of the Columbia School of Mines, who have shared the prospector's camp fire, his blankets, his flapjacks, and his beans. You will give credit to whom it belongs. To the man with the faith of a child and the heart of a viking, to the man who has tramped and toiled until he heard 'the mile-wide mutterings of unimagined rivers and beyond the nameless timber saw illimitable plains'; to the miner who has crossed the last range of all and lies in the only prospect hole he could not dig; to the man who was the herald of empire and the pioneer of industry; to him who blazed the trail."

Efficiency of Steam

By E. B. Wilson

On comparing the heat units that coal possesses with the useful work which steam engines exert, it will be found that not one-tenth of them can be utilized in the most modern power plant. It is not intended to go into any long discussion over losses due to radiation, incomplete combustion, etc., but to explain the conditions from the resultant end. It is assumed therefore that 1 pound of coal contains 14,500 heat units; that is, 1 pound of coal will raise 1 pound of water 14,500° F., or 14,500 pounds water 1° F.

As water is converted into steam at 212° F., 14,500° F. should convert 68.4 pounds water into steam ($14,500 \div 212 = 68.4$); but an excellent evaporation under a boiler is 7 pounds of water per pound of coal, or $7 \times 100 \div 68.4 = 10.2$ per cent. of what should occur.

The standard boiler horsepower in the United States is an evaporation of 30 pounds of water per hour from a feedwater temperature of 100° F. into steam at 70 pounds gauge pressure, or the consumption of $\frac{30}{7} = 4.29$ pounds coal per boiler horsepower hour. If there is a loss of 10 pounds pressure between the boiler and the engine from various causes and steam is used at 70 pounds pressure, 14.2 per cent. more coal is to be added to the 4.29 pounds to keep up the boiler horsepower (or $.61 + 4.29 = 4.9$ pounds). The various appurtenances about a boiler such as feed pump, blower, and loss from leaks and radiation will vary, but may be roughly estimated to consume 2 per cent. of the evaporation or $(7 \times .02) = .14$ pound

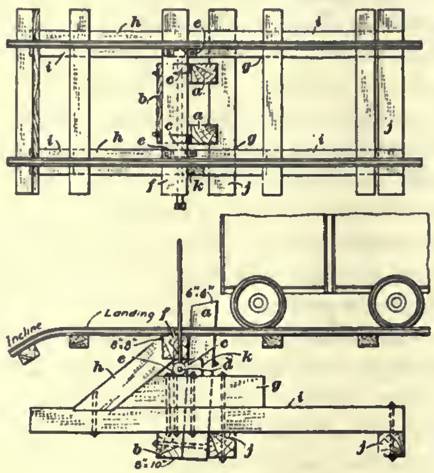
coal + 4.9 = 5.04 pounds is required up to this point.

There is considerable coal consumed in banking the fires for 14 hours and in raising steam in the morning, and this is probably one-tenth of the coal consumed in regular running, or .504 pound per pound water evaporated, a total of 5.54 pounds per horsepower hour. Assume that a 100-horsepower engine is to be driven and that it has an efficiency of 80 per cent., then the boiler horsepower must be 100 ÷ .8 = 125 horsepower.

This in coal is represented as follows: 5.54 × 125 × 10 = 6,925 pounds coal per day. From these calculations it has been deduced that only 6.5 per cent. of the heat units in the coal are available in the engine. In case electric power is generated, and the generator has an efficiency of 85 per cent. it would require (100 ÷ .85) 1.18 per cent. power in terms of coal or 8,171.5 pounds per 100 horsepower, but an electric horsepower is equivalent to 1.34 steam horsepower, therefore 10,950 pounds of coal will be required. Reducing this to terms of heat units it will be found that their efficiency in electric power is 4.11 per cent.; that is, if the heat units from 82.2 pounds of coal could be utilized without loss they would furnish 100 kilowatt hours, where at present it takes the heat units from 10,950 pounds of coal. This is an efficiency of less than 1 per cent. in electrical output.

Safety Block for Inclines

To prevent the accidental return of a car or skip that has been hoisted to the top of an incline and detached, the device shown in the accompanying drawing is recommended by the State Mine Inspector of New York. It consists of two almost upright timbers *a*, fastened to the square shaft *d* by the straps *c*. The shaft is turned in two places to fit the boxes *e*. The bottoms of the timbers *a* are bolted to a transverse piece *b*. The hoisted car hits the timbers *a*, which revolve with the shaft, permitting the car to pass. The weight of *b* then brings them to the upright position and the cross-piece *f* prevents their swinging in the other direction. To release the car, the lever, which is attached to a square portion of the shaft, is used to force the timbers down below the level of the axles. The specification



Safety Block

of material for installing the device on an incline with a track of 3-foot gauge is given in the table.

Specifications of Materials for Safety Block

Timber

a	2 pieces	6 in. ×	8 in. ×	4 ft. 4 in.
b	1 piece	8 in. ×	10 in. ×	2 ft. 2 in.
f	1 piece	8 in. ×	8 in. ×	5 ft.
g	2 pieces	8 in. ×	10 in. ×	4 ft.
h	2 pieces	8 in. ×	8 in. ×	3 ft. 2 in.
i	2 pieces	8 in. ×	8 in. ×	10 ft.
j	2 pieces	8 in. ×	8 in. ×	5 ft.
k	1 piece	5 in. ×	6 in. ×	1 ft. 1 in.

Iron

4 bolts ¾ in. × 20 in.
2 bolts ⅝ in. × 14 in.
2 bolts ⅝ in. × 17 in.
2 bolts ¾ in. × 28 in.
2 bolts ¾ in. × 34 in.
4 bolts ⅝ in. × 10 in.
2 bolts ½ in. × 18 in.
1 shaft 1 15/16 in. × 1 15/16 in. × 4 ft. 4. in.
1 piece ⅝ in. × 1½ in. × 5 ft.
2 clamps for shaft
2 boxes 2½ in. × 8 in. × 2 in. bore

The above drawing and specification will require amendment to suit the gauge of track, but with such an appliance in use accidents could not happen by neglect to put the stop-block in position, and no car could descend until the attendant pulled the lever. It would cost a little more to fix than the primitive block and bolt, but would save life.

The Leckie Collieries Co. and the Dougher Mining Co., both controlled by William Leckie, will each open a new mine near Williamson, W. Va.

Elimination of Accidents by Mining Machines

*By J. M. Tulley**

During the past few years, undercutting mining machines have become almost indispensable in our mines, where labor is scarce and a large tonnage is required. In mines where the coal is undercut before the miner is allowed to enter the mines, they not only increase the efficiency of the miners, but also add safety, as they practically eliminate all chances of careless miners shooting coal off the solid.

At the various plants of the United States Coal and Coke Co., there are six different types of mining machines, all of which are giving very good service; namely, the Sullivan Low Bed, 6-foot cutter bar; Sullivan Standard, 6-foot cutter bar; Sullivan, 8-foot cutter bar; Sullivan Iron Clad, 10-foot cutter bar; Jeffrey Standard, 6-foot cutter bar; and Jeffrey, 8-foot cutter bar, all known as shortwall machines. These machines will cut coal with the props set to within 5 feet 6 inches of the face. We at first started to mine coal with the Standard Sullivan machine with a 6-foot cutter bar, cutting from right to left, or from left to right, known as a right-hand or a left-hand machine. These machines would not undercut coal so deep in narrow places as to allow the miners to make efficient headway, and with the safety of the workmen in mind, it was decided to use a longer cutter bar, as wider places might prove dangerous. We also decided that a machine which would cut either right handed or left handed, by changing bits, would be more efficient and less dangerous than pulling a machine from one side of a room to the other to start cutting, so after explaining what was wanted, the Sullivan Machinery Co. built a machine after the type of their Standard 6-foot machine with an 8-foot cutter bar. This is a very efficient machine, but will only cut to the left. Next, the Jeffrey Mfg. Co. built us six Jeffrey machines

*Supt. No. 2 Plant United States Coal and Coke Co., Gary, W. Va., at the company's Booster Dinner.

with 8-foot cutter bars that will cut either to the right or left. These were built with the same gearing as the Jeffrey 6-foot bar and this would not run the cutter chain fast enough to clean the machine, and caused a strain on the machine and cable. Then the manufacturers furnished new gearing, which runs the cutter chain much faster, causing it to cut freer and faster. The 12-inch truck wheels were also taken off and replaced by 18-inch truck wheels which increased the efficiency of the machine 50 per cent.

The next move was to purchase from the Sullivan Machinery Co. four 10-foot cutter bar machines of the Iron Clad type, made to cut in either direction; these are very satisfactory machines, and probably the next order will be for 12-foot cutter bars, for all mining machines.

A coal cutter of any make is a poor machine if not properly taken care of. No machine will work well where the track is not properly bonded; where the wires are not of sufficient size to furnish it the proper current, where the wire is grounded, or with dull bits or dead lugs in the cutter chain, or without oil or grease. A machine should be cleaned after each shift and not allowed to accumulate dirt and dust until it breaks down and the repairman comes in to clean it and finds the cause of the trouble. It is very important that the proper bits be used for cutting different kinds of coal. In the Pocahontas No. 4 seam a pick pointed bit in the middle and on the top, and a chisel pointed bit on the bottom, are found much more efficient than any other combination of bits. Every mining machine should be equipped with an electric lamp, in good order, at all times, so as to increase the efficiency and assure the safety of the men running the machine. Mining machines should be examined by the Safety Committee on Machinery, to see that they are well guarded and the cutting should be looked after by the Safety Committee on Mining, to make sure the coal cutting is performed in the safest way.

The machine runner should go to each place he has been instructed to cut and see if his foreman has marked the place O. K.; if marked O. K., he should examine it thoroughly before unloading his machine and see that the condition of the roof and face are still good. He should then unload his tools at their proper places and unload his machine. He should put his tool box or a small prop under the rear end of the truck to hold that up and keep the front end down on the rail, thus making it much easier to reload the machine. After cutting sufficient coal, he should sprag it to keep it from falling out from the face and perhaps striking either the men or machine.

In making safety the first consideration, the man running the machine should look after the safety of himself, his fellow workmen, his machine, and the safest way of cutting coal, so that the miner can break and load the coal in safety.

Enthusiasm in the safety work surpasses rules, regulations, and safeguards. Single handed, the enthusiast convinces and dominates, where safety devices and rules would scarcely raise a tremor of interest. Safety enthusiasm tramples over prejudice and opposition, spurns inaction, storms the citadel of its object, and like an avalanche, overwhelms and engulfs all obstacles.

It is nothing more or less than faith in action. Faith and initiative rightly combined remove mountainous barriers and achieve the unheard of and miraculous. Set the germ of safety enthusiasm afloat in your department; carry it in your attitude and manner; it spreads like contagion and influences every fiber of your industry before you realize it; it begets and inspires efforts you did not dream of; it means increase in safety and decrease in loss of life; it means joy and pleasure and satisfaction to your workers; it means life, real and virile; it means spontaneous bed-rock results.

Then let us become well enthused here tonight at this Safety Boosting banquet and pass our enthusiasm in safety work on to our safety committee and to our men working at the face so that at the end of 1914 we can be as enthusiastic over what we have accomplished as tonight we are over what we wish to accomplish.

Gas Testing Devices

Several attempts have been made to supplant the miner's gauze safety lamp by devices employing platinum black or sponge, or the like. This will detect methane, but would be useless for blackdamp. The platinum speedily gets out of order, and generally speaking it is necessary to employ a battery which will often get out of order, and possibly fail at an unexpected moment. In other devices the well-known principle of the difference in rate of diffusion of different gases has been employed. These, however, lose their indicating properties after being in the gases for a few minutes, as the difference in reading on the scale produced by comparing with the standard air is quickly lost if the instrument is kept in the gases for many minutes, and the user would scarcely know when it was in working order, especially if he failed to keep the instrument under constant observation. Either of these types of instruments would obviously be unsuitable for a collier, would also be too expensive and delicate to place under his control, and each would no doubt fail at a moment when it ought to give the miner unmistakable evidence that something was wrong. His flame lamp would certainly do this, as it would refuse to burn when a certain percentage of gas was reached and the miner would be compelled to clear out. If an odd oil lamp be hung at the entrance to the working place this would get neglected, and in any case its failure to automatically compel the miner using electric lamps to vacate his place (seeing he has from the electric lamps light enough to continue with his work) makes this system of odd oil lamps placed here and there, open to many objections.

WITH THE EDITORS

THIS being the time of the year when the annual first-aid competitions take place, the November Colliery Engineer will be a special first-aid number and will contain reports and descriptions of the principal contests of the season. For this reason the descriptions of a number of important meets that have taken place have been held to appear with the rest.

THE opposition to the use of steam shovels in stripping comparatively light cover off coal seams near the surface in certain sections of the country, is based on two "faults": (1) A steam shovel is not eligible for membership in the local labor organization, and (2) notwithstanding its efficiency as compared with human labor, it can't vote.

THE whole "civilized world" was horror stricken when the great steamship "Titanic" was wrecked with the loss of about 1,900 human lives. A mine disaster causing the death of 100 mine workers, no matter how carefully the mine management may have been in endeavoring to safeguard the employes, invariably and rightfully excites the pity of all classes for the unfortunate victims and their families, and often unjustly excites condemnatory expressions against the mine management. When crowned heads plunge their nations in a great war, causing the daily loss of many thousands of lives, the destruction of property of incalculable value, the impoverishment of their subjects, and the making of thousands of wives widows, and more thousands of children orphans, it makes one doubt whether there is such a thing as a "civilized world." These crowned heads rightfully compel their subjects to settle their disputes peacefully in courts. That they do not settle their own disputes by arbitrament, gives the lie to their claims that they reign *Dei gratia*. If God is not a God of peace and justice, then the religion the same crowned heads profess to believe is false.

Will the War Be Beneficial?

THE civilization of a nation depends on its natural resources and the ability of its people to make use of them. During the last few weeks we have been suffused with information relative to our great opportunities to get the trade with the South American republics which the great European maritime nations had previous to the war in which they are now engaged. As we lack shipping facilities and international banking arrangements, we are in the position of the hungry tramp, who said if he had some ham and some eggs and some matches he would have some ham and eggs.

With the view to aiding the coal operators of the United States to expand their markets at a time when the exporters of other coal producing countries are inactive, the Bureau of Mines has issued a bulletin describing the various coals which are best available for foreign shipment. It is to be hoped that our coal operators in some way can take advantage of this situation, but here comes the rub, the English and French oppose our purchasing vessels for this or any other export trade; ostensibly because the money would relieve German exigencies, but as we see it, they fear that the vessels in the hands of unscrupulous Americans would furnish Austria and Germany with contraband of war.

A direct benefit from this war would accrue to the United States if its citizens would now start in and build a merchant marine; would develop natural resources and manufacture materials from them for which we are now dependent on foreign nations; and also if they would through suitable banking arrangements develop a system of credits whereby our manufactured articles would be bartered for the raw materials and food products of South America.

That an expansion of trade was possible did not require the European war to show; however, some people have to put their fingers on a buzz saw to see if it is going around.

So far the war has greatly injured the United States, because through short sightedness we are unable to take advantage of the opportunities offered, and in addition has interfered with industry. With due respect to Whipple, we are led on this occasion to paraphrase his words and say: The voice of the statesman never made a steamship, neither did the sword of the warrior or the pen of the writer. If you would see the true need of a merchant marine we would show you the millions of bushels of wheat and golden corn, the bales upon bales of cotton that cannot reach those who need them most; and then we would show you the peaceful conditions in our shipyards if there are any left, and explain to you what might be accomplished in the way of giving employment to the many now idle through no fault of theirs.

It has been our boast that we were independent of all nations and could produce anything we need. So far, so good, but we cannot sell all we produce, and without a merchant marine we are as bucolic as the farmer 150 miles from the railroad with a truck farm.

The Transportation Problem

NATURALLY being more interested in coal mining from the producing end, than in the transportation problem of the railroads, we have perhaps been overcredulous in condemning the carriers for the biennial difficulties that occur in the industry.

The facts as presented from the operators' side are that during the spring and summer months the railroads are able to furnish 100 per cent. car supply, while during the fall and winter months they are able to furnish only 50 per cent. car service, based on the physical rating of the mines. We have then a condition where enormous capital investment has opened and maintained coal mines with capacity rating from 150 to 200 per cent. greater than the normal consumption. The carriers have contributed somewhat to this overproduction of mines by constructing lines into new fields and making lower rates on long hauls, moving coal beyond the economical zones and delivering it into already congested markets.

Not so long ago the operator was privileged to listen to frank statements from railroad men who expressed the opinion that the untoward conditions prevailing in the mining industry were largely due to lack of management, and that if the same ability were applied to this as to transportation the result would be more satisfactory.

The operator is satisfied that if the same business ability and acumen were bestowed on transportation problems as are applied to mining, the car service would be more satisfactory.

If the reader is familiar with Mark Twain's Huckleberry Finn and the illustration of the two tramps on the raft, he will be impressed by the similarity of these differences of opinion to the inscription under that picture, namely, "Jawing."

The carriers have received much criticism, shall we say deservedly, for their inability to furnish 100 per cent. car service during the periods of abnormal demand, but if they were in the position to furnish 100 per cent. car service at all times, would it not furnish a congested coal market, decrease prices, and put a large number of operators out of business? Believing that it would do so, it seems as if it were fortunate for some coal operators that the railroads are unable to furnish this car supply.

While it is policy for railroads to encourage the opening of new mines, both for present and prospective business, it is impolitic for them to supply 100 per cent. car service 4 months in the year and allow 50 per cent. of their rolling stock to remain idle 8 months of the year.

C. G. Hall, secretary of the International Railway Fuel Association, Chicago, figures that to furnish 100 per cent. car supply in Indiana and Illinois, five of the large coal carrying roads would have to purchase 250 new locomotives, and 30,000 cars, making a total investment of $30,750,000, the annual interest on which at 5 per cent. would amount to $1,537,500. This is only a small part of the total expenditure these five roads would have to make in order to handle the coal as the operators now demand, because the cost of tracks and yard facilities to accommodate these cars would far exceed the cost of the rolling stock. The burden of the investment would be shifted, of course, to the consumer, and no particular benefit be derived by the operator, because of the ruinous competition that would ensue if there was 100 per cent. car supply. While fully aware that the millenium is not here and that the railroad lion and the lamblike operator are not ready to present the pastoral peacefulness which lying down together would suggest, nevertheless the two industries are so closely allied that their relations should be amicable and fair. In some cases, operators are and have been treated unfairly in the matter of car allotment, and this should be adjusted; on the other hand, the operators must find means whereby they can produce coal regularly during the year instead of trying to mine and ship 300 days' sales in 175 days.

Explosion and Fire

At the Grafin Laura Colliery, Konigshütte District, on January 15, 1911, a fire broke out in the Gerhard seam of the Grafin Laura pit. The fire watchmen noticed smoke in the air-current. They went in search of the fire, but were driven back by the fumes, and it was decided to dam off the section in question. The doors in four existing masonry dams were closed and work was begun on two additional dams, which, however, were disturbed on the following day. An explosion of gas then blew out several of the doors and injured five of the men. The dams were repaired, and channels left to relieve the pressure of the gas within were soon afterwards found to be letting in air, and were accordingly closed up. In the following June (1911), the section was found to be gas free; the dams were opened, and the work of removing the coal and debris and repairing the timbering damaged by the explosion was begun. Three weeks later, however, before the seat of the fire was reached, gas made its appearance, and the dams had to be closed again. At intervals of 3 months, the air-current was then twice sent through the section. On the second occasion, in June and July, 1912, the work of clearance was continued up to the seat of the fire, but on gas again appearing, the section was once more shut off, to be finally opened in 1912. The fire was attributed to spontaneous combustion of the roof coal, which was very rotten and broken. It broke out Sunday, so that no men were in the section at the time.—*A. R. L. in Trans. I. M. E.*

The Summit Hill, Pa., mine fire is estimated to have destroyed $26.-000,000 worth of coal in 51 years, and to have cost about $2,000,000 in the attempts made to quench it.

Adaptability of West Virginia Coals

To By-Product Coking—No Appalachian Coal Should be Declared Non Coking Without an Oven Test

*By E. B. Wilson**

PROF. E. N. Zern made the caption of this article and demanded that I write to it. Of course to be picked in such a manner is flattering, nevertheless there seem to be more interesting angles to the subject, to me at least, than those he suggests. To determine whether a coal will coke, the Max A. Pishel test is advocated, which simply amounts to pulverizing fresh coal in an agate mortar with an agate pestle. If the coal adheres so strongly to the tools that it is difficult to remove it, the coal will make good coke; if it does not adhere strongly it makes a medium grade of coke, and if it does not adhere to the mortar or pestle it will not coke. This test will probably hold true for all coals where the intention is to coke them in beehive ovens; however, since many coals will coke in by-product ovens that fail to coke well in beehive ovens, the test must be narrowed. It is self-evident that when a coal will coke in a beehive oven it will also coke in a by-product oven, but at this date no Appalachian coal can be declared a non-coking coal without a test. To test the coking quality of any coal a good sized sample should be sent to an oven plant and treated on a commercial scale.

The best coking coals in West Virginia are the Pocahontas beds of the Tug River district, the Sewell and Beckley beds of the New River district, the Upper Freeport bed worked by the Elkins Coal and Coke Co., at Richard mine, 4 miles northeast of Morgantown, and the Pittsburg bed in northern West Virginia which turns into the Georges Creek bed in the Potomac district to the east of Fairmont. At the Elk Garden No. 6 mine, this coal is semibituminous, while at Morgantown and Fairmont the same bed, if the correlation is correct, is bituminous.

It is probable that all semibituminous coals will coke and make metallurgical fuel, but unfortunately being 20 per cent. and under in hydrocarbons, they coke in the beehive oven at the expense of their fixed carbon. On the other hand, semibituminous coal furnishes more coke when carbonized in by-product ovens than bituminous coal higher in hydrocarbons; however, it does not furnish such large quantities of by-products as coal containing more than 20 per cent. in hydrocarbons.†

By making use of the analyses of Connellsville and Pocahontas coals, to calculate the amount of coke which should be obtained from them, and then comparing results obtained from practice in beehive and by-product ovens, some interesting data are obtained.

Connellsville coal should, according to chemical analyses and calculations, furnish 68.38 per cent. coke; in the beehive ovens it furnishes 64 per cent. coke; in by-product ovens 72 per cent.

An analysis of Pocahontas coal suggests its theoretical coking yield to be 79.41 per cent. in coke. In beehive practice a good yield is 62 per cent.; in by-product practice the yield has reached 85 per cent.

The impression has gained ground that semibituminous coal swells so much in coking it becomes difficult to manipulate. This, however, does not hold true; in fact this kind of coal does not swell so much as higher volatile coal, when properly heated in by-product ovens.

It has been customary, in fact is a good plan, to mix one-fifth of high volatile coal with four-fifths of semibituminous coal for the purpose of getting a mixture carrying 25 per cent. hydrocarbons and by this means obtaining a gas richer in by-products.

It has been stated that the Pittsburg bed coal will not coke in by-product ovens on account of its being an easily melting coal that sticks to the sides of the ovens, or burns to graphitic carbon, becoming overdone at one place and underdone in another. The Connellsville coal has been coked successfully in by-product ovens and is, we understand, being coked at South Bethlehem, Pa., at the present time in an inferior oven, known as the "Dider-March."

This coal, a West Virginia product, from the Elkins Coal and Coke Co., is mined by our Mr. J. B. Hanford.

It will be noticed that the best coking coals in the United States are, according to certain kinds of pessimists, not suited to by-product coking, when as a matter of fact they are coked and can be coked in suitable ovens when the process is carried on by intelligent heaters. No matter what the coal or mixture of coals may be that are charged in by-product ovens, there must be a degree of skill attached to the process that is not necessary in beehive ovens.

Frequently chemists make reports on coal and call the residue that remains after driving off the volatile matter by heat "coke." We have known office engineers and geologists to make statements from such analyses that the coal was a coking one, when the residue might be from anthracite or a non-coking variety of coal that had no more cohesion than sand. If the coal is not semibituminous, the surest way of determining its value as a coking proposition is to send a carload to some coke plant and have it tested in the ovens, provided there is any adhesion to the particles after carbonization.

Most any of the West Virginia coals will produce coke, and some which are not considered good coking coals will furnish excellent coke in by-product ovens when crushed and properly heated.

*Read at the Cumberland Meeting, W. Va. Inst.

†Proceedings W. Va. Coal Mining Inst., 1910, p. 390.

The by-product oven opens a way, therefore, to make some coals more valuable than they are at present. For instance, Illinois has a vast field of coal in its southern part which

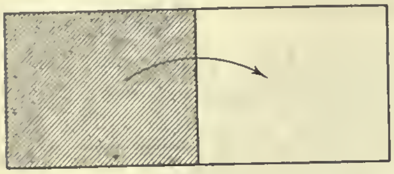


Fig. 1

is not coked, in fact very few, if any, ovens are coking native coal in Illinois. A plant of beehive ovens was erected near Harrisburg, Saline County, another at Ziegler, Franklin County, and perhaps others, but the coke produced was not satisfactory.

That mined and used at Ziegler is Illinois No. 6, or Big Muddy coal, and when it is crushed and coked in by-product ovens, the results are quite satisfactory. An analysis of Ziegler coal from Bulletin 290, United States Geological Survey, is as follows: Moisture, 9.90; volatile matter, 28.67; fixed carbon, 53.69; ash, 7.74; sulphur, .48.

From this analysis it is evident that, if coked, the coal would make excellent metallurgical fuel. The St. Bernard Coal and Coke Co., Earlington, Ky., made coke from this bed in beehive ovens, but in Illinois the operation has not been successful. This sample of coke was made from 100 per cent. Big Muddy, Illinois coal, taken from the Keller mine, located at Sesser, Franklin County, Ill., about 85 miles southeast of St. Louis, in the Big Muddy field. This particular piece was coked in a Semet-Solvay oven at Detroit, Mich., and is part of a full charge that was coked in 16 hours. The same coal has been coked in Koppers by-product ovens; but Mr. N. deTaube, assistant to the managers of the Big Muddy Syndicate, to whom I am indebted for this coke sample, did not consider it a normal product and kindly sent what he calls a normal product, made under conditions of high temperature, and, as you coke men can see, is an excellent piece of coke, sound, and comparatively bright.

It is evident from the sample that if it were mixed with an easier melting coal the two would make a coke that would rate as high as any. Mr. Leo Glück, of the Pittsburg Coal Co., once put the question: When does a coal cease to become a coking coal and become a gas coal? The answer is: When the volatile hydrocarbons are in such proportion that carbonization does not furnish sufficient material to produce a profit over that which could have been obtained by selling the coal raw.

As an illustration, assume coal to be worth $1 per ton and coke $2; also that one coal contains 25 per cent. hydrocarbons and another 35 per cent.; then if the cost of making coke and putting it on the car is 60 cents, the 25 per cent. hydrocarbon

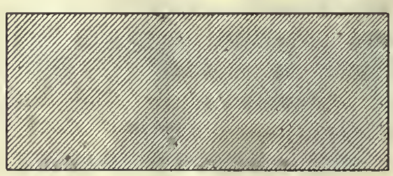


Fig. 2

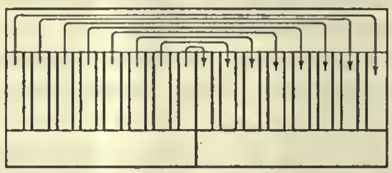


Fig. 3

coal requires 1.33 tons coal for 1 ton of coke and costs $1.33. Thirty-five per cent. hydrocarbon coal requires 1.53 tons of coal for 1 ton of coke and costs $1.53.

The cost of coke would then be $1.93 and $2.13 per ton, consequently the 35-per-cent. hydrocarbon coal becomes gas coal. This argument refers to coking the coal in beehive ovens, for by-product ovens would return a profit from such coals, as the by-products are more valuable than any dollar coal coked, besides an increase in coke which varies from 200 to 500 pounds over the beehive ovens would convert the so-called gas coal into a coking coal. Fatty coals high in hydrocarbons, while prolific in by-product materials, do not as a rule furnish as good metallurgical coke as coals which contain about 25 per cent. hydrocarbons. This is due to the slower and imperfect distillation of the hydrocarbons. In fact if they are not crushed fine, the outside of a piece of coal will coke while the inside remains uncoked. It has been proved that the only way to obtain coke from dry coal, such as the Illinois No. 6 and the Indiana block, which may contain as much as 32 per cent. hydrocarbons, is to crush it and make use of the by-product oven. It is probable that West Virginia contains no coals that cannot be made to coke either alone or by mixing with known coking coals, provided by-product ovens are adopted.

One objection generally raised against by-product ovens is their high cost. In answer to this, Mr. Frank Haas is quoted:‡ "This by-product business in the United States is going to be one of the great things in the near future. I think we have an exaggerated idea of the cost of these ovens. When one speaks of an oven costing $5,000 it frightens us if we compare it with our beehive which costs from $300 to $500. But if we figure it out in cost per ton of coke, we are surprised at the low cost of the by-product oven."

Another objection raised against by-product ovens is the quality of the coke. In the eyes of some, good coke must be silvery, a color only obtained by watering coke inside the oven. This objection is answered by asking: Who ever smelted iron with silvery color? Any one who has made coke, knows that its quality is not injured by being watered outside the oven even although it is turned black.

Fig. 4

Another objection raised is that by-product coke is spongy and absorbs more water than beehive coke. This is true in a measure, if Con-

‡W. Va. Coal Mining Inst. Trans., 1910, p. 395.

nellsville and Pocahontas cokes are the basis for comparison; but even then much depends on the kind of oven and the treatment given the coal during the coking period. It seems logical to argue that the water absorption is overruled by other considerations, because of the large concerns increasing their by-product oven capacities and using yearly more of this kind of coke; however, with Connellsville beehive coke, containing 2.5 per cent. of water and some by-product cokes containing 7.5 per cent. of water, the furnace man receives in 1 ton of coke 50 pounds of water in one case and 150 pounds in the other case. Several factors enter into watering conditions that may account for part of the water in by-product coke, but probably the main factor is due to oven construction, and the changes in temperature which occur in coking. With the exception of the Semet-Solvay and Mueller, the by-product ovens at present most in evidence, heat half of the oven directly and half indirectly, alternation being necessary where regenerative stoves are in use to comply with the oven's construction. This is graphically illustrated in Fig. 1, where cross-hatching shows one end of the oven heated direct and the blank space shows the oven heated by the products of combustion. Every 20 or 30 minutes the heat is reversed so that periodically there are fluctuations of temperature amounting to 300° C. or 572° F., with attendant checks in the progress of coking. According to thermometer reading made of Koppers ovens at Gary, Ind.,§ it requires 10 hours to raise the temperature in the center of the oven charge from 200° F. to 380° F., 10 hours to raise the temperature of the charge on the sides of the oven from 200° F. to 1,220° F. and 10 hours to raise the temperature of the charge half way between the two points from 225° F. to 420° F. To heat the charge to a uniform temperature throughout, required 16½ hours, thus showing the slow conductivity of coal and coke as a conductor of heat, and the checks to coking which must inevitably occur when one-half the oven has the required temperature to advance the coking and the other half is at a standstill. Aside from affecting the quality of the coke by causing cracks, this constant change of temperature in the oven walls seriously injures the brickwork and it is said that on this account regenerative ovens of this kind have a shorter life and require more repairs than waste-heat ovens.

Another feature in construction which it is believed caused several engaged in the by-product oven business to declare that Connellsville coal would not coke in by-product ovens, is the distance the gases have to travel in the oven, as will be noted from Figs. 1 and 3. Naturally the gases will take the shortest route to the chimney, consequently the flues nearest the middle or division wall will have the strongest draft and will carry the bulk of the hot gases, leaving a smaller quantity for the flues nearer the ends of the oven, and this makes the ovens hottest near the division wall, a fact which can be visually observed and which demands great care on the part of the heater to prevent the coal sticking to the sides. To provide a uniform heat throughout an oven, each flue must be provided with the same quantity of air and gas, and the temperature must be held constant and not allowed to fluctuate. Indirect firing will furnish good coke at *a*, Fig. 4, if properly fired, as less fluctuations occur in this zone. It will also furnish overdone and burned coke if the heater is not careful to keep the heat down, in which case coking in other parts of the oven say *b* will be slow and, as is ever the case with slow coking, a spongy product will result. Interesting and instructive deductions have been drawn by Professor Parr in the Bulletin which he wrote for the University of Illinois on "Coking Coal at Low Temperatures."

§J. R. Campbell, Vol. X, p. 80, Eighth International Congress of Applied Chemistry.

It Counts Either Way

To avoid the loss of rail in the gob and in the mine, Manager H. V. Hesse, of the Maryland Division of the Consolidation Coal Co., has issued the following circular:

To all mine foremen: Please refer to Engineer Walter's circular letter of December 16, 1913, regarding monthly T rail report.

Please be advised that, in this connection, you will get no credit for worn-out rail that has not been measured. We consider worn-out rail as having a scrap value which will generally pay for moving it from the mine to the outside.

The Engineering Department has instructions to check measurements on this worn-out rail just the same as rail lost or new rail. If our measurements do not check with your report on worn-out rail, it will be reported as having been lost and charged accordingly.

All worn-out rail is to be brought outside and placed on the scrap pile, where the measurements will be checked by the Engineering Department. In case these instructions can not be carried out, it is your duty to bring the matter to our attention, so that necessary checking can be done in the mine.

Carbon Blast-Furnace Hearths

In Brymbo Iron and Steel Co.'s furnace, which has been in blast 5½ years (the whole time on basic iron) the hearth has never been more than 18 inches below the tap hole. The carbon block hearth is now within an inch or two of its original level, as the tap hole was laid out 12 inches above the carbon hearth to start with. Sometimes a firebrick hearth loses very much more in the first week or two than the carbon hearth has done in more than a year. Judging by the fact that the carbon hearth in Bolckon Vaughn & Co.'s (England) furnace has not worn at all during the last three months, it gives promise of a long life.—*Cleveland Inst. Eng., Eng.*

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Doors

Editor The Colliery Engineer:

SIR:—Frequently my attention has been called to explosions of gas in anthracite mines and gas and dust in bituminous coal mines where the cause is attributed to leaving a door open and short-circuiting the air-current.

I should like to ask your readers if there is any reason why a door should be placed on an entry, especially a haulage entry? Aside from the expense connected with its construction, repair, and attendance, it seems to be a menace to life in more ways than one, and individually no single example occurs to my mind which makes its use more than temporarily imperative and then not on main haulage roads. If one were to examine into the causes for accidents during the past year it is probable that over 200 lives will have been said to be lost through air-currents being short-circuited, doors left open, etc. That being the case, why have doors and in addition to accidents pay about $365 a year for attendance and repair?

A WORRIED MINE FOREMAN

Responsibility—Another Side

Editor The Colliery Engineer:

SIR:—I have read several articles on the line of "Responsibility" which appeared in a recent issue of THE COLLIERY ENGINEER. There is no doubt that article expressed a truth, but *responsibility* does not always rest on the miner, as the following actual occurrence will show.

Recently, while working as a miner I noticed the top in my room becoming dangerous. I sought the foreman and said: "Mr. X., the top in my room has become so heavy and the crevices are so large that I am afraid to work under it." "Set some props," he answered. The next day, after loading two wagons, I again went in search of the foreman and said: "Mr. X., the top in my room requires some cross-bars, as well as props." He answered, "No, sir. No cross-bars will be used; you can hold it with props."

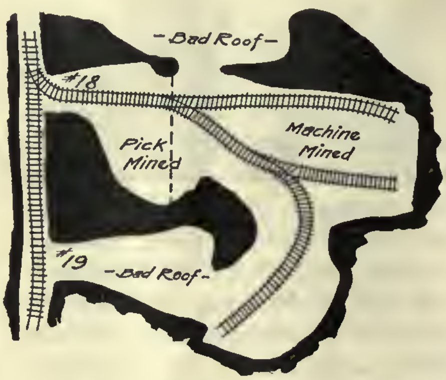


FIG. 1

My coworker and I went home, remained out 2 days, and requested a committee to investigate the conditions. A committee, or rather one man, visited the room, and he admitted that the top was bad, and to make it safe it should be well timbered with cross-bars above the road.

The assistant foreman then came and told us to clean some of the top already fallen, and to hold the top with props. This we did. But it was providential that neither of us was hurt or killed. The assistant foreman assured us that the top would never fall, and that he could give us no better room. Nevertheless, in just 2 months the top did fall.

From this place I went to work in rooms 18 and 19, see Fig. 1. Some time later I again went to the foreman and said: "Mr. X., the road in our room is so bad it needs repairing." He replied: "Rather than use iron rails in that room I prefer to take the whole business out." "Well," I said, "the old rails break, and the cars get off the track." "Let them get off," he replied, "the jackman is there, and the tracklayer, too." I told him that the driver asked us to hold back the cars, to retard acceleration, and in spite of our doing this, they occasionally jumped the track.

He replied to this, "Well, I told you the jackman is there; he's paid for it."

Our earnings were decreased by time lost in lifting derailed cars on the track, in fixing and repairing roads, by topping consisting of lumps being thrown to the floor and breaking into slack, and by the necessity of rebuilding topping. Besides this, the danger was increased, and finally when a car jumped the track, my coworker had his foot caught between the rail and the rear bumper, and he received painful injuries that resulted in a loss of 41 days.

When the foreman gave us rooms 18 and 19, No. 18 was driven about 40 feet, and No. 19 was stopped on account of bad roof. I enclose the sketch to show that in this case the direction of the work in the mine was not only deficient as regards safety, but was inefficient as to proper mining methods.

AN EXPERIENCED MINER FROM THE MODEL MINES OF FRANCE

Retreating Mining

Editor The Colliery Engineer:

SIR:—I am interested in the problem of the best plan of retreating mining to be used in working out a seam of coal 4½ feet in thickness, covered with 35 to 40 feet of soft shale and slate, with an occasional ledge of limestone 1 to 3 feet thick running through same. Above this portion of the cover lies a 9-foot seam of coal which has been worked out by the usual advancing room-and-pillar work, and over this seam lies 100 to 140 feet of soft shale,

slate, and clay, with an occasional ledge of lime rock.

The process of mining the upper seam has produced a great number of surface cave-ins, and the nature of the roof is such that the same trouble may be expected in the lower seam to an even greater degree than in the upper, on account of the increased depth, as well as the liability of pillars from the upper seam punching through into the workings below. The nature of the cover is such that heavy falls of roof reaching to the surface are of frequent occurrence. Owing to the ease with which the roof breaks and caves, squeezes are as a general thing practically unknown. The floor under the lower seam consists of one or two feet of fireclay, at times approaching the texture of soft shale, and below this comes a sandy limestone or pure sandstone for 5 or 6 feet, underneath which the shales are again found.

It occurs to me that the most practicable method might be to drive entries to the boundary and use the room and pillar retreating system, pulling all pillars as rapidly as the progress of the work will allow. Ample provisions for taking care of drainage will, of course, have to be provided.

It should be stated that the workings of the upper seam for the greater part have not been handled in such a manner as to allow of keeping the pillars in the lower seam in alinement with those of the old workings above. The greater part of the workings in the upper seam are many years old and were driven in the day when it was not considered necessary to survey and map the workings in an accurate manner. G. E. L.

Fig. 2 is a plan we have had in mind which consists essentially of retreating room and pillar work. The furthest panel is shown entirely worked out and the pillars drawn; the other panels and entries back toward the shaft are shown in a diminishing stage of development, as would be natural when working from the face back toward the hoisting shaft.

Were there no pillars standing in the old workings above, we would suggest longwall retreating, but there is about 40 feet only of cover besides danger of the pillars punching through to the lower seam. Under these circumstances about the best method to follow, in our judgment, is to drive entries 8 feet wide to the boundary and take up about 1 to 2 feet of bottom to the sandstone.

This will give head room, but if the top is bad it may be necessary to leave about 1 foot of coal. In laying out the small panels the rooms might be driven 15 feet wide on 50-foot centers and by so doing hold the pillars in the upper seam while robbing progresses. By means of the small rooms the work will be concentrated and should progress rapidly and uniformly.

There is a good opportunity in this question for some one to explain how roof pressure would act in this case.—Editor.

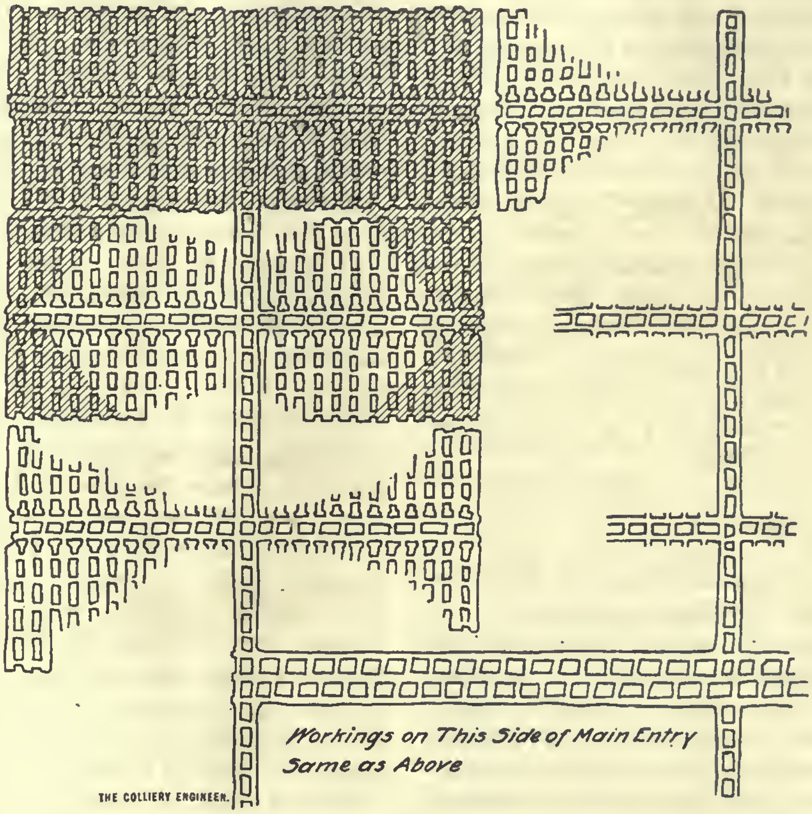


Fig. 2

Conditions in Mines

Editor The Colliery Engineer:

Sir:—I am but a small cog in this mass of human machinery, but there are things which interest me that I would like to have larger cogs explain if they kindly will.

1. I think the mine that is considered safe is the most dangerous because not enough attention is given to make the dangers common to all mines secure. I consider the firey mine with its rules and regulations to guard against explosions safer than one which gives off but a small volume of gas and in which open lamps are used; because a rock fall may send gas from worked-out places into the live workings, where it may be ignited. I am opposed to mixed lights in a mine, for a fall in the barometer may permit an extra volume of gas to exude from the coal, or roof of old workings and thus furnish an explosive mixture of sufficient quantity to at least ignite dust. As gas may exude from any part of an excavation, it may happen that a place in which no gas has been detected may suddenly give

off sufficient gas to be ignited by a long-flame explosive, or an open light. If there is any gas in a mine, therefore, no mixed lights should be used, and then there will be fewer mines exploded.

2. I think that the air needed in a mine should be determined by the analysis of the return air near the discharge, and that enough should be coursed through the mine to furnish from 19 to 20 per cent. oxygen. There may be more air passing through the mine than the law demands, but unless it is distributed properly, complaints will be heard of bad air.

3. In our district we have a fireclay bottom which when wet becomes soft, and so we place the big end of the prop down. I would like to hear from some one relative to this method of prop setting under this condition.

O. L. Bullock

Cleaton, Ky.

Longwall Method for Ohio

Editor The Colliery Engineer:

Sir:—It is my belief that more coal and better coal can be recovered in eastern Ohio if longwall is practiced. At Glencoe, in Belmont County, the No. 8 Ohio, or the Pittsburg coal bed of western Pennsylvania and West Virginia, is from 55 to 100 feet or more below the surface. The rocks above the coal are shales, sandy shales, limy shales, thin limestones and sandstones and the No. 8a, Pomeroy, or Redstone, coal bed. This coal bed is of no account, since it is impure, varies from 4 inches to 15 inches in thickness, and when it attains the latter thickness becomes slaty.

The thickness of the No. 8 coal with its partings is 5 feet 6½ inches. Above the coal is 10 inches of draw slate, soapstone, and above that 1 foot of coal.

The three benches of coal below the soapstone are termed "breast coal" 2 feet 4¼ inches thick; bearing in coal 3 inches thick; and "brick" and bottom coals 2 feet 11¼ inches thick. No. 8 bed is not clean coal, in fact there are six pyrite partings in the section given. From the draw slate to the "brick" coal there are four pyrite partings making 3¼ inches in all. In the "brick" and bottom coal there are two pyrite streaks totalling ¼ inch, thus 3½ inches of the bed is sulphur band. In machine mining, about 4 inches of coal is left on the bottom so as to cut in between the sulphur bands which are 4 inches apart. The coal is excellent when cleaned, and I believe if mined longwall it would be gotten in larger lumps and less mixed with dirt.

In longwall mining, after development has reached a point where the roof begins to bear down, the squeeze helps the miner to break down the coal by cracking it. The soapstone also works loose and requires little work on the part of the miner to remove it, and therefore is safer than in machine mining as now practiced, where the posts must be kept some distance back from the face. The soapstone would always be ahead of the fall and is valuable for building roadways and cogs. Having seen the longwall method practiced under nearly similar conditions in Lochgelly splint coal, Fife, Scotland, I am convinced it is the proper method of obtaining the maximum output of lump and clean coal in eastern Ohio from No. 8 bed.

In longwall mining, all cribbing must be kept as close to the face as possible and properly packed from bottom to top. This is the most economical method of procedure and it pays to do it right, for the future of the method depends on this work being well done, particularly face entries, through which the coal must be handled so long as the mine lasts.

Face entries should be driven ahead of the work and butt entries are merely a continuation of the longwall, cutting off worked-out faces and branching to new. Old railroad ties would make the best kind of cribbing at branching off roads, for there wooden cribs must be used to start an entry, because no kind of rock has been found suitable for sharp corners, but crumbles and falls out under pressure. Butt entries should not be placed too far apart, so that room roads could be easily cut off by new butt entries, as they progress. It is cheaper to do this and gob close to the coal face, than to allow it to hang back and have to load in trucks afterwards. I am in hopes the longwall system will be given a trial in the near future.

John Shepherd

Glencoe, Ohio

Permissible Electric Mine Lamps

The following communication has been received from a manufacturer of electric mine lamps:

"Why should the Bureau of Mines issue a new schedule on portable electric lamps in which they advise and suggest certain mechanical changes which must meet the ideas of the engineers in the Bureau of Mines, many of which have nothing whatever to do with the safety features of the lamp?

"It is up to the Government Bureau of Mines to test lamps for safety and not permit any lamp that is not safe in the mine. It is not up to the Bureau of Mines to suggest or insist upon certain methods of construction—certain requirements regarding the life of the lamp bulbs or the size and shape of the reflector. It is entirely up to the various manufacturers of portable lamps to produce their own ideas and submit same to the Bureau of Mines for test, and the Bureau in turn should test the outfits for safety. If the Bureau of Mines interferes with the progress of the manufacturers of electric lamps, they will place the industry in jeopardy, due to the fact that the manufacturers will at no time have a standardized outfit, and the operators in turn will hesitate about placing orders for lamps, when the type of construction may be changed any moment. Furthermore, it would be a hardship for a manufacturer to keep on changing the construction of his outfit every year or so, compelling him to keep on manufacturing supply parts for all the outfits which are at present being used. Later on, this will no

doubt cause a great deal of confusion and annoyance with the operators, due to these continual changes. We all realize that we are living in a competitive world, where one competes with another, each one endeavoring to turn out a better outfit than the other. Therefore, it is entirely up to the manufacturers of these lamps to build their outfits in the best possible manner, and it is natural to suppose that the best manufactured lamps will be installed to the greatest extent."

The policy of the Bureau of Mines in regard to portable electric miners' lamps is given on page 12 of Technical Paper No. 75; where the "Bureau considers that a safe electric lamp is really a safety device whose universal adoption in connection with a proper number of oil safety lamps for gas testing, will make coal mining conditions safer by reducing the fire and explosion hazards and by making easier the detection of bad roof." "The Bureau is at present seeking to aid the development of portable electric lamps by analyzing the qualities that such lamps should possess and suggesting what these qualities should be."

The first requisite is the production of light.

The next is the weight of the lamp.

The third is the cost of operation.

The Bureau is interested in electric lamps along lines of safety and efficiency, because lamps have been offered on the market which were unsafe and under claims so far from the facts that there was danger of this excellent device being retarded in its application because of failure, not only in regard to safety, but also in regard to efficiency.

The writer of the article we know would make any change that would improve the lamp he represents, and as the lamp he represents has been passed by the Bureau as a permissible electric lamp, we do not feel as he does in the matter. If the Bureau has the right to declare a lamp permissible, it has the right to declare that the construction of a lamp shall meet its requirements, and if the manufacturer thinks it is necessary for the success of his lamp to have it dubbed "permissible" he must change its construction.

Editor

Relative Rubbing Surfaces

Editor The Colliery Engineer:

Sir:—Three airways each 6,000 feet long have the same cross-sectional area of 75 square feet. One is circular, one is square, and a third rectangular, 5 × 15. What are the respective rubbing surfaces?

F. C. Curvin

Cleveland, Ala.

First find the various perimeters:

The area of a circle $= \pi R^2 = 75$, $R = \sqrt{\frac{75}{\pi}}$.

The perimeter of a circle $= 2\pi R = 2\pi\sqrt{\frac{75}{\pi}} = \sqrt{300\pi} = \sqrt{942.48} = 30.70$ feet.

Rubbing surface = length × perimeter.

Rubbing surface = 6,000 × 30.70 = 184,200 square feet.

The area of a square is the square of any side = 75 square feet.

Therefore, one side $= \sqrt{75} = 8.66$.

Perimeter = 4 sides = 4 × 8.66 = 34.64 feet.

Rubbing surface = 6,000 × 34.64 = 207,840 square feet.

The perimeter of the rectangular airway is the sum of the four sides or 40 feet, then, rubbing surface = 6,000 × 40 = 240,000 square feet.

The Rumford Medal

Benjamin Thompson (Count Rumford) was born in Woburn, Mass., March 26, 1753, and died at Auteuil, France, in 1814. He was made a Count in Bavaria, where his investigations conclusively disproved the fluid theory of heat which was then commonly held. In 1799 he founded the Royal Institution of Great Britain. The American Academy of Arts and Sciences awards the Rumford Medal to those who discover, invent, or make improvements that are of great merit to society.

Notes on Mines and Mining

NOVA SCOTIA

The Dominion Coal Co., in July, closed down the International colliery (Dominion No. 8 mine), which takes from the list of producing collieries what was probably the oldest colliery in Nova Scotia. Coal has been mined from the International area since 1858, the shaft recently abandoned having been sunk in 1863. The mine in its lifetime has produced about 5,380,000 tons of coal, of which 66 per cent. has been mined since the property passed into the hands of the Dominion Coal Co. Up to 1907, naked lights were used, the workings being but shallow, and it is worthy of record that no serious disaster has visited the mine at any time.

Dominion No. 17 colliery, formerly known as the Victoria mine, was recently pumped out and was in a position to give up to 700 tons daily output, but owing to the depression in trade, further development has been discontinued. The mine will be kept unwatered, but permanent construction is indefinitely delayed.

The general lethargy in manufacturing, particularly as affecting the steel industry, has now seriously affected the production of the Nova Scotia collieries, and the products of the coal trade are of course very uncertain because of the war. All the Nova Scotian collieries are operating on short time. For the 8 months ending August the aggregate output of the mines of the Dominion Coal Co. totals 3,300,000 tons, showing a falling off as compared with last year of 80,000 tons. Under the depressed conditions this must be regarded as a satisfactory showing.

Shipments to Montreal and the St. Lawrence are unaffected by the war, the British Admiralty having established an effective cruiser patrol. Some slight reduction in the working force has been occasioned by the calling of French and Belgian reservists, together with the mobilization of the local militia and the

British forces, but owing to the congested state of the labor market, the loss is not serious.

The Nova Scotia government has offered to the British government 100,000 tons of coal as a gift, to be used to coal the warships which are patrolling the Atlantic.

The Cunard liner "Mauretania" which slipped into Halifax after the declaration of war by England, was coaled by the Dominion Coal Co. and reached Liverpool safely after a record breaking run of 4½ days from Halifax.

PENNSYLVANIA

The labor situation continues quiet, and some of the operators are inclined to attribute this to Billy Sunday's campaign in the anthracite regions of Pennsylvania last winter. They tell of prayer meetings in the machine shops at noon, and of cottage meetings at night, and state that the saloon in many districts is neglected for these.—*P. & B.*

The Lehigh & Wilkes-Barre Coal Co. shipped 1,000 tons of egg coal to San Francisco through the Panama Canal. This is the first anthracite by this route, although it has been shipped to San Francisco by boat as ballast going by way of Cape Horn. It is estimated that it will take the Lehigh & Wilkes-Barre shipment 30 days to reach its destination.—*P. & B.*

No exodus of reservists of the warring and interested nations is reported, although many of the mine workers are natives of them. Russians, including Poles, Lithuanians, and Slavonians, predominate, and next come Italians, Irish, Austrians, and Hungarians, Welshmen, Germans, and Englishmen in the foregoing order.—*P. & B.*

WEST VIRGINIA

The Jenkins Coal Co., operating at Mabie, W. Va., have removed their general office from Elkins to the above mentioned plant.

Earl Henry, Chief of Department of Mines of West Virginia, announces that the Eccles mine, in Raleigh County, which was blown up on April 28, resulting in the death of 180 miners, is now ready to resume operations. The mine has been repaired throughout. The shaft relined, air-course enlarged, all overcasts and stoppings rebuilt of concrete, the mine thoroughly cleaned of all dust accumulations and a pipe line system laid to all parts of the mine for the purpose of watering down dust after the mine resumes operations. Only safety lamps will be permitted in the mine. The operating company claims to have a long list of applicants for work and expects to start with a full force in a very short time.

Factors in the Process of a Coal-Dust Explosion

The behavior of a coal-dust explosion depends primarily on its initial cause and on the degree of agitation during its first moments, as well as on the composition of the dust layer and the form of working in which it takes place. Accordingly as the clouds of dust encountered are more or less favorable to propagation, and the walls cause a more or less eddying of the air-current, a generalized explosion will, or will not, ensue at the outset and be more or less violent. The behavior may also be influenced by what occurs in the parts of the working to which, or from which, it proceeds. An explosion produced in the gallery of a testing station constitutes, therefore, a special case, which does not reproduce all the factors that may be present in actual practice.

One of the chief objects of the Lievin experiments is to verify theoretical deductions, and to determine the coefficients corresponding with the various circumstances that may be met with in mine working and also the different laws applicable to them. Every element of complication that may present itself, such as a bend, branch, blind end, obstruction, etc., should form the subject of close study and investigation, destined to furnish means for foreseeing and preventing their effects in complicated cases. Such investigations were taken in hand as a sequence to the fourth series of experiments.—*J. Taffanel, Annales des Mines, Paris, 1912, S. 2, V. 2, p. 5.*

Claims on the National Forests

In the annual report for 1912, Henry S. Graves, Chief Forester of the United States Agricultural Department, a large part is devoted to a discussion of various kinds of claims under which title to land within the forests is sought. Nearly a thousand homesteads were taken up under a special act which provides for opening to settlement land suitable for agriculture. The report states, however, that some old homestead claims were instituted for the purpose of securing timber, and the same is still true of some mining claims.

"As attempted frauds under the mining laws are usually resorted to by interests in no way associated with mining, similarly the vast majority of homestead frauds are not chargeable to practical farming; but the appeal to popular prejudice has been made in the name of the mining industry and in the name of the farmers of the country."

"The mining laws," Mr. Graves says, "afford the greatest cloak for land frauds in the national forests, and fraudulent mining claims are initiated by men and interests having no connection whatever with the mining industry." The mining laws, for example, have been used to cover townsite and timber claims, to secure farms, ranches, to secure mineral springs, sites for saloons, waterpower sites, and stock watering places.

"It has often been asserted that the national forests have operated as a bar to legitimate mining development. Figures collected in Colorado during the past year show that, if anything, there is more activity in prospecting on the national forests that outside. The proper relations of the forest service with the mining industry should be cooperative."

Answers to Examination Questions

Questions Selected From Those Asked at an Examination for First and Second Grade Mine Foreman and Fire Boss, Held in the Bituminous Regions of Pennsylvania, May 5, 6, 7, and 8, 1914

Ques. 1.—An airway, 7 ft. × 8 ft. and 1,000 feet in length, is passing 20,000 cubic feet of air and gas a minute, the proportions of the mixture being one of air and one of gas; by reducing the quantity of air one-half, what would then be the velocity, in feet per second, and what would be the result if a lighted safety lamp was placed in the current?

Ans.—The length of the airway need not be considered in the answer as the velocity is independent of the length. The velocity at first is $20,000 \div (8 \times 7) = 20,000 \div 56 = 357$ feet per minute, about. As the mixture contains 10,000 cubic feet each of air and gas, after the quantity of air is reduced one-half, the air-current will consist of 5,000 cubic feet of air and 10,000 cubic feet of gas per minute, a total of 15,000 cubic feet. The velocity per minute will be $15,000 \div 56 = 268$ feet per minute, or $268 \div 60 = 4.47$ feet per second.

As the mixture will consist of two parts, or 66⅔ per cent. of gas and one part, or 33⅓ per cent. of air, a lighted safety lamp, when placed in it, will be immediately extinguished.

Ques. 2.—(*a*) In a mine that is being worked with open lights, describe what conditions may be encountered that would require the use of locked safety lamps.

(*b*) Would you consider it safe to use open lights in any portion of a mine generating explosive gas? Give reasons for your answer.

Ans.—(*a*) Gas in dangerous amounts may be given off suddenly or unexpectedly from the tapping of a natural gas or oil well driven through the mine workings; when approaching or passing through a fault or clay seam; by striking a feeder of gas in the coal bed or in the rocks enclosing it; by a heavy fall of roof, or a squeeze; and, possibly, by a sudden and marked fall of the barometer, particularly where there is a large and open worked-out area adjacent to the working places.

(*b*) This part of the question is not capable of a direct answer. The amount of gas given off by a seam increases from nothing or from a minimum at the outcrop to a maximum at the most distant working faces where the cover is heavy. Further, causes or conditions that may possibly result in outbursts of gas as explained in (*a*) may generally be anticipated and precautions taken to render them harmless, or else, while the amount of gas given off by or caused by them is much greater than under ordinary conditions, the increase is so gradual that ample time is given for the withdrawal of the men before the explosive point is reached. Consequently universal custom sanctions the use of open lights in those parts of a gaseous mine where gas has never been detected or were present in such small amounts that the ventilating current is sufficient to so dilute it that it will not show a cap on the safety-lamp flame.

On the other hand it is evident that to be absolutely safe no means of making a light which involves the generation of sufficient heat to ignite methane is permissible underground whether the mine is partly or entirely gaseous, for the reason that sudden outbursts of gas are possible even if but remotely so.

Under the conditions of the question, mines are now worked with the portable electric lamps which have been approved by the Bureau of Mines, and safety lamps are used merely for testing for gas.

Ques. 3.—A current of 3,000 cubic feet of air and gas is at its most explosive point; how much air should be added to dilute the mixture so as to show only a faint cap on the safety lamp?

Ans.—At its most explosive point, firedamp contains 9.38 per cent. of gas. The above mixture would, then, consist of $3,000 \times .0938 = 281.4$ cubic feet of gas and $3,000 - 281.4 = 2,718.6$ cubic feet of air.

The percentage of gas that will show a faint cap will depend upon many things, chief of which is the ability of the observer to detect it. Assuming, however, that the ordinary skilled observer can distinguish the cap produced by as little as 2 per cent. of methane, in order that 281.4 cubic feet of gas may constitute 2 per cent. of the mixture of air and gas, the volume of the latter must be $281.4 \div .02 = 14,070$ cubic feet. But the existing volume of gas and air is 3,000 cubic feet. Hence there must be added to it $14,070 - 3,000 = 11,070$ cubic feet of air, in order to reduce the proportion of gas to 2 per cent.

Ques. 4.—(*a*) What are permissible explosives? (*b*) What conditions make their use necessary in a mine? (*c*) What charge limit has been established by the United States Bureau of Mines for such explosives?

Ans.—(*a*) A permissible explosive is a mixture of different chemicals used for blasting coal which has successfully passed a series of tests made by the United States Bureau of Mines. It is of the high explosive type and contains compounds which burn with a very short flame as compared with black powder; in some cases ingredients are present which reduce the temperature of the products of combustion.

(*b*) The presence of explosive dust, particularly if methane is present, demands the use of explosives of this type. They are called permissible explosives as their use is allowable or permissible under the described conditions which are those where black powder cannot be used.

(*c*) The maximum amount of permissible powder that may be safely used in a single shot is 1½ pounds.

Ques. 5.—If the rubbing surface of an airway is 72,000 square feet and its length 4,000 feet, what is its perimeter?

Ans.—The perimeter is found by dividing the rubbing surface, in square feet, by the length of the airway, or $72{,}000 \div 4{,}000 = 18$ feet. This is the perimeter of an airway 3 feet high and 6 feet wide, having an area of $6 \times 3 = 18$ square feet, which is extremely small.

Ques. 6.—In working a dusty mine where marsh gas is given off, what steps would you take to guard against accidents from explosions?

Ans.—Prohibit shooting off the solid, and undercut the coal to a depth from 3 inches to 6 inches more than the length of the longest shot hole. Use permissible powders only, not more than 1.5 pounds in any one hole, and use clay for tamping. See that the shots are properly balanced, that dependent shots are not fired together, and that the firing is done by electricity, preferably after the men have left the mine. Clean up all bug dust, or machine cuttings, at the face and carry it from the mine. Use tight cars and do not overload them. See that the tracks are cleaned regularly and that the road dirt is carried from the mine and not stowed in the gob or breakthroughs. For lighting, use the portable electric storage battery lamps which have passed the safety tests provided by the Bureau of Mines. Provide an ample air-current, carry it to the working faces where necessary through proper splitting and keep the amount of methane in the return airways below 1 per cent. Before shot firing, wash down the working places, roof, floor, and ribs, for from 60 to 80 feet back from the face. Wash down the roof, floor, and ribs of the entries at such short intervals that while they are not muddy, yet the road material may be made into balls in the hands. If water is not available for this purpose or if it is found cheaper or otherwise desirable, the working places and entries may be treated to a coating of finely powdered shale dust in sufficient amount to render the coal dust inert. This shale dust may be used on shelves along the entries to establish what are known as barriers. Old and abandoned workings in which dust and gas are apt to accumulate should be securely walled off with air-tight stoppings. Where electricity is used, the rules laid down by the laws of the state and the Bureau of Mines should be carefully followed.

Ques. 7.—A sump is 60 feet long, 10 feet wide, and 8 feet deep, and full of water; how long will it take a pump 6 inches in diameter (water end) to empty this sump at a piston speed of 100 feet per minute, if the efficiency of the pump is 80 per cent.?

Ans.—The volume of water in the sump is $60 \times 10 \times 8 = 4{,}800$ cubic feet. The area of the water cylinder is $\frac{1}{4}\ \pi\ d^2 = .7854 \times 6^2 = 28.2744$ square inches, or $28.2744 \div 144 = .1963$ square foot. Since the piston travels 100 feet per minute, it will pump $.1963 \times 100 = 19.63$ cubic feet of water each minute. This is the theoretical amount pumped; the actual amount is 80 per cent. of this, or $19.63 \times .80 = 15.70$ cubic feet per minute. A pump of this capacity will empty the sump in $4{,}800 \div 15.70 = 306$ (about) minutes, or 5 hours 6 minutes.

Ques. 8.—How should mine timber be set where the roof is strong and the bottom of a soft fireclay nature, and, also, where the bottom is hard and the roof is tender with frequent slips?

Ans.—Where the floor is soft, in addition to the cap on top of the post, the latter must be set on a foot-board of sufficient thickness and area to prevent its being broken or pushed into the floor when the weight comes on the post.

Where the bottom is hard the foot-board is not required. Where slips are frequent, what is known as systematic timbering is usually adopted. In this, posts of the required diameter are set at a fixed d i s t a n c e a p a r t, checker-board fashion, whether a slip appears at the place where the post is set or not. The posts are set from 5 to 6 feet apart, and have caps of more than the usual length.

Ques. 9.—The water gauge reads 2 inches, the velocity of the air-current is 500 feet per minute and the length of the air-course is 4,000 feet; what would the water gauge read if the length of the air-course was extended to 8,000 feet and the velocity of the air-current was increased to 800 feet per minute?

Ans.—The formula for the pressure in terms of the dimensions of the airway and the velocity is $p = \frac{k\,l\,o\,v^2}{a}$. Since the perimeter o, area a, and coefficient of friction k, are the same in both airways, these terms may be omitted and p varies as lv^2. Using capital letters to denote the longer airway, we have the proportion $\frac{p}{P} = \frac{lv^2}{LV^2}$, in which p and P are the pressures, l and L the lengths, and v and V the velocities. Strictly speaking, $p = 5.2$; and $P = 5.2\ I$ (i and I being the water-gauge readings), but since this is equivalent to multiplying both the numerator and denominator of the ratio $\frac{p}{P}$ by the same number 5.2, the step is unnecessary and for p and P

we may use the readings of the water gauge. Substituting the given values

$$\frac{2}{P}=\frac{4,000\times 500^2}{8,000\times 800^2}=\frac{1\times 5^2}{2\times 8^2}=\frac{25}{128}.$$

From this $25\,P = 2\times 128 = 256$, and $P = 10.24$ inches = increased water gauge.

Ques. 10.—What are the efficient limits to which the ventilation of a mine may be split?

Ans.—When splitting is carried too far, that is, when there are too many splits taking air from one intake and delivering it to one return, the velocity of the air in the several splits is reduced to such an extent that neither the products of combustion (powder and lamp smoke, exhalations of men and animals) nor gases given off by the coal are carried away as rapidly as formed. This reduction in velocity is due to the fact that all the air enters through one opening and, after passing through the several splits, leaves the mine through the one return. This congestion of the air greatly increases the resistance in both the intake and return, and, the power being the same, reduces the pressure at the mouth of each split and, consequently, the velocity in each.

Ques. 11.—If 20,000 cubic feet of air per minute is passing through an airway with 3.15 horsepower and the quantity is increased to 40,000 cubic feet per minute, what will be the water gauge?

Ans.—It is first necessary to find the horsepower required to move the increased quantity of air. One formula for the horsepower is $\text{H. P.}=\frac{k\,s\,q^3}{33,000\,a^3}$. Since there are no changes in the dimensions of the airway, the only term not common to both is q, whence it follows that the horsepower varies as the cube of the quantity of air in circulation. But the quantity of air is doubled ($40,000 \div 20,000 = 2$), hence the horsepower must be increased in the proportion of $2^3 = 8$. From this, if 3.15 horsepower moves 20,000 cubic feet of air per minute, it will require $3.15\times 8 = 25.20$ horsepower to move 40,000 cubic feet of air per minute. The pressure per square foot in terms of the horsepower and quantity may be found from the formula

$$p=\frac{33,000\times \text{H. P.}}{q}=\frac{33,000\times 25.20}{40,000}=20.79 \text{ pounds.}$$

The water gauge reading is found by dividing the pressure per square foot by 5.2 or $20.79 \div 5.2 = 4$ inches = water gauge required to circulate 40,000 cubic feet of air per minute, when it requires 3.15 horsepower to move 20,000 cubic feet.

The problem may also be solved by first finding the water gauge corresponding to 3.15 horsepower. Using the last formula

$$p=\frac{33,000\times 3.15}{20,000}=5.1975,$$

say 5.2 pounds per foot. From this, the water gauge $= 5.2 \div 5.2 = 1$ inch. The water gauge increases in the ratio of the squares of the quantity of air in circulation, and to double the quantity will increase the water gauge reading $2^2 = 4$ times. Hence, when 40,000 cubic feet of air are moving, the water gauge will read $1\times 2^2 = 4$ inches.

Ques. 12.—If the ventilation of a mine was insufficient, and the ventilating power was working to its fullest capacity, what would you do under such conditions to increase the ventilation?

Ans.—If the mining operations have been properly conducted and the fan installed at the outset does not produce sufficient air after the workings have advanced some distance from the drift mouth, the quantity of air in circulation can be increased only by putting a new and larger fan in operation.

Before buying a new fan, however, it would be well to go over the workings in order to see that there are no unfavorable conditions the removal of which would add to the capacity of the fan. Return airways are too frequently allowed to choke with falls; if these are cleaned up, the friction will be reduced and the quantity of air in circulation be increased. Leaking brattices will prevent a full circulation of air to the face, and leaking overcasts will reduce the amount of air in the split they connect to the return. By reducing the amount of air in one split a greater quantity of air may be diverted through another split where it is more needed; and the velocity of the current may be sufficiently great to warrant the use of one or more additional splits to carry air to poorly ventilated parts of the mine. If, after the above unfavorable conditions have been rectified and no changes can be made in the fan that will cause it to draw more air, the workings are still insufficiently ventilated, a larger fan is necessary as stated in the first paragraph.

Ques. 13.—A fan running 40 revolutions per minute is producing 100,000 cubic feet of air with a water gauge of 1 inch; if the speed of the fan is increased to 60 revolutions per minute, what would be the quantity of air produced and height of water gauge, and what would be the horsepower required?

Ans.—It is generally assumed that the quantity of air discharged by a fan is proportional to the number of revolutions it makes per minute. On this understanding, the quantity discharged at 60 revolutions per minute may be found from the proportion, $40 : 60 = 100,000 : x$, from which $x = 150,000$ cubic feet per minute. This ratio does not hold in practice and the actual amount discharged by the fan will be, say, 10 to 15 per cent. less than the calculation gives.

The water gauge varies as the squares of the quantities of air in circulation, or $100,000^2 : 150,000^2 = 1 : x$. By dividing the first two terms by 10,000, the proportion reduces to $10^2 : 15^2 = 1 : x$, or $100 : 225 = 1 : x$, from which $x = 2.25$ inches = water gauge at 60 revolutions per minute.

The theoretical horsepower may be found by substituting in the formula

$$\text{H.P.}=\frac{5.2\times i\times q}{33,000}=\frac{5.2\times 2.25\times 150,000}{33,000}=53.2.$$

Strictly speaking, both the water gauge and horsepower will be less

than obtained above, but the foregoing figures err on the side of safety.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Coal Mine Bulletin No. 7, Illinois. Bulletin 7, "Coal Mining Practice in District II," by S. O. Andros, published by the Illinois Coal Mining Investigations, describes mining conditions in Bed 2 in Jackson County. Owing to the superiority of this coal it has been in such constant demand that it has been mined continuously for 40 years, and now only a small acreage remains, the district at present producing less than 1 per cent. of the annual tonnage of Illinois. Mining practice differs from that in districts in northern and northwestern Illinois where Bed 2 is also mined. A feature of the bed is its division into two benches by gray laminated shale, varying in thickness in some mines from ⅛ inch to 36 feet. Where the parting is less than 4 inches thick, the two benches are worked as one, and where the parting is thicker than 4 inches the lower bench only is mined, and the parting becomes the mine roof. Arching the top coal in entries has proved successful in reducing timber cost in the district.

Copies of the bulletin may be obtained from the Illinois Coal Mining Investigations, Urbana, Ill.

Smelter Construction Costs, by E. Horton Jones. Published by the McGraw-Hill Book Co., New York City. 150 pages, illustrated. $2 net.

The book is one on "Unit Construction Costs" from the new smelter of the Arizona Copper Co., at Clifton, Ariz. It presents each page as a "sheet" and divides the book into six chapters. In the first, on Unit Costs, are to be found the most elementary total unit costs provided for in the accounts. In the second chapter on Comparative Costs, these are classified and can be applied to similar conditions anywhere. So on through the book the author treats composite costs, wage scales, prices of raw material, concluding with a chapter on description of prices. The last account is particularly interesting, in that it gives a short description of the way each dollar was spent.

The Coal Field Directory. This book, published by the Keystone Consolidated Publishing Co., of Pittsburg, Pa., contains a directory of the coal mining companies in the United States and catalog descriptions of the various types of mining equipment manufactured.

Besides listing all the officials and executives of companies, "The Directory of Mines" contains the name and location of each individual mine, including shipping point and railroad connections, geological name of seam mined, whether by hand or machine, class and amount of equipment at each mine, the actual output for the last fiscal year, number of coke ovens, if any, and the number of employes. For the convenience of machinery salesmen and coal salesmen, this directory section is gotten up in pocket edition form, size 4×6, ¾-inch thick, flexible cover, printed on India paper. The information contained therein is procured direct from the mining companies; consequently it is authentic.

Dominion Coal Co.—We have received an illustrated souvenir booklet prepared for the Dominion's Royal Commission which visited the Dominion Coal Co., Ltd., in August, 1914. This souvenir was gotten up by Mr. F. W. Gray and besides describing the coal areas, collieries, railways, loading docks, discharging plants, and auxiliary operations of the Dominion Coal Co., it is profusely illustrated with excellent half tones.

Modern Tunneling, by David W. Brunton and John A. Davis, 450 pages, 6½ in. × 9 in., 80 illustrations. Price $3.50. John Wiley & Sons, New York, publishers. There are few books on this subject and much of the material they contain is now historical. The authors treat of tunneling methods in the United States, discuss them, and make suggestions that they hope will result in saving life, energy, and capital that would otherwise be expended in useless work. Chapter IV deals with the choice of power for tunnel work. Chapter VI is on Ventilation. Chapters VIII to XIV cover rock drills, drilling methods, blasting, loading, and timbering. There are chapters on Safety, Cost of Tunnel Work, and Outline of Tunnel Data.

Mining World Index of Current Literature, for the first half of 1914, is for sale. Price $2, Mining and Engineering World, Chicago, Ill. This is an international bibliography of mining and the mining sciences compiled from the index of current literature appearing weekly in the *Mining and Engineering World.*

Iron Ores is the title of a book by Edwin C. Eckel. The volume has 430 pages, 6 in. × 9 in., is published by McGraw-Hill Book Co., New York, and is sold for $4. The material presented in this volume has been worked over at intervals, during many years of professional activity, and certain sections have been published. Mr. Eckel says: "The volume as it now stands represents an attempt to discuss iron ores, not merely in their geologic and technical relations, but in their more general relations to industrial conditions."

Mr. Eckel is much too modest to occupy the Kaiser's throne, so the last sentence is edited as follows: The volume is an Economic Treatise on Iron Ores. The book is divided as follows: Part I, The Origin of Iron-Ore Deposits. Part II, The Valuation of Iron Properties. Part III, The Iron Ores of the World. Part IV, Extent and Control of Iron Ore Reserves. The book covers a broad scope and the subject is treated entirely from the geologist's viewpoint.

PERSONALS

Geo. Watkin Evans, consulting coal mining engineer, who recently examined the Matanuska coal fields of Alaska for the United States Navy, is in Montana on professional business.

Prof. H. H. Stoek, of the University of Illinois, arrived safely from the war zone in September.

L. H. Underwood has been appointed assistant superintendent of the by-product coke department at the Gary, Ind., works of the United States Steel Corporation. Mr. Underwood was with the National Tube Works at Riverside near Benwood, W. Va.

The Bulletins gotten up by S. O. Andros for the Illinois Coal Mine Investigation, are attractive and are being much discussed. In the field work he has been assisted by J. J. Rutledge, of the Bureau of Mines, C. M. Young, and R. Y. Williams, of the State Geological Survey of Illinois.

Prof. Francis Church Lincoln, formerly at the University of Illinois, is now Professor of Mining and Metallurgy at the Mackay School of Mines, Reno, Nev.

C. E. Sharpless, general manager of the Nant-Y-Glo Coal Mining Co., has moved from Cresson to Ebensburg, Pa., in order to be in closer touch with certain important parts of his work.

George L. Miller, superintendent of the Kettle Creek Coal Mining Co., died recently at his home near Westport, Pa. He was 65 years of age.

John Britt, chief of the mine clerks of the Pittsburg Coal Co., became auditor of the Berwind-White Coal Mining Co. at Windber, Pa., on September 9.

The directors of the Monon Coal Co. have elected George G. Yeomans as president, to succeed F. A. Delano, who became a member of the newly organized Federal Reserve Board.

In the *Daily Circular and Trade Report* of August 25, Lorin A. Lathrop quotes interesting figures from the 1913 report of the Chief Mine Inspector for the United Kingdom.

Frank Bache, president of the Bache-Denman Coal Co. of Kansas, has been appointed receiver for the Coronado Mammoth Vein, Prairie, Hartford, Sebastian County, Denman, Kali-Inla, and the Bache-Denman coal companies. The surface works of five of these companies were destroyed in July by union strikers.

Architect Henry Hornbostel has completed plans for the proposed experimental station for the United States Bureau of Mines to be erected in Pittsburg, Pa., and to cost $500,000.

A. J. Houle has been appointed Professor of Metallurgy and T. G. Chapman Assistant Professor of Metallurgy in the Michigan College of Mines, Houghton, Mich.

The Bureau of Mines Car in charge of J. C. Roberts is making an extended tour. It will be at Storrs, Utah, October 10; Castle Gate, October 17; Schofield, October 24; Winterquarters, October 31; Clear Creek, November 7; and return on November 8 to Salt Lake City, Utah.

Franklin K. Lane, Secretary of the Interior, has been interviewed by some one who took him for an Economic Geologist. His replies were such that he showed he had been studying Mineral Resources of the United States.

Prof. V. Dolmage, of Columbian College, New Westminster, British Columbia, and J. D. MacKenzie, of the Canadian Geological Survey, are reported to have been injured by an explosion of gas while exploring an abandoned coal prospect on Graham Island, B. C.

E. Jacobs, of Victoria, B. C., was official scorer at the First-Aid Meet in Seattle, Wash., an account of which will appear in our November issue.

Dwight C. Morgan, president, and Frederick Norman, chief engineer of the Allegheny River Mining Co., have completed the design of a new steel tipple to cross the river at Logansport to their Nicholson No. 1 mine.

Legal Decisions on Mining Questions

Liability of Mine Owner for Labor and Material.—(Colorado) The owner of a mine which was leased is not liable to one who furnished labor and materials which benefited the mine, unless he encouraged it, or, knowing that plaintiff looked to him for payment, made no objection.—*Reynolds vs. Norman, 141 P. 466.*

Issuance of Store Orders by Mining Co. Illegal.—(United States Supreme Court) Singling out persons, firms, or corporations engaged in mining and manufacturing as the ones to be forbidden to issue orders for the payment of labor not purporting to be redeemable in money, as is done by virtue of the Virginia statutes, does not render such statute invalid under the Federal Constitution, 14th Amendment, as class legislation denying equal protection of the laws to all. The suit is one in which the plaintiffs in error, the Keokee Consolidated Coke Co., issued orders on itself directing the payment to bearer "in merchandise only from the store" to the value specified. The defendants in error, who were the plaintiffs in the lower court, having a number of these orders in their possession, brought suit to compel the coke company to honor the orders and pay them in money in accordance with the law of Virginia requiring payment to be made in money. The contention of the coke company was that the law in question was unconstitutional, in that it interfered with the right to contract and that it singled out mining and manufacturing enterprises and required them to pay in money, yet not placing any obligation on other industries. The United States Supreme Court, in reviewing the Virginia Court of Appeals, affirmed the holding of the Virginia Court and said that the Virginia law does not interfere with the right or

obligation of contracts, and does not create class distinction between different industries. In passing such a law the legislature took into consideration the needs and demands of the different industries. It had a right to exercise its judgment as to the different situations.—*J. P. Kelly et al. vs. Keokee Consolidated Coke Co., 34 Sup. Ct., 856.*

Mine Owner Cannot Anticipate All Accidents.—(Kentucky) The Supreme Court of Kentucky, in Wallace *vs.* Columbia Coal Co., has held that a mine owner cannot anticipate all possibilities of accident and where not at fault cannot be charged in damages for an injury received by a miner. The facts of the case are that the plaintiff was employed as a driver to haul coal from the drift of the mine to the tipple. He had been employed about 18 months before the accident, and had been over the track and manipulated the switch levers, while the cars were in motion about 50 times a day. At the time of the accident, as he approached the first switch going from the tipple, he undertook to adjust it, and in attempting to catch the lever lost his balance and fell over the side of the car. While trying to get on the car, he passed a post about 25 feet from the switch, located 14 inches from the track, and, while still in the act of trying to regain his balance, he was caught between the post and the car and thrown to the ground, and received the injuries complained of. While it was customary to adjust the switch while the car was in motion, this was a matter which the plaintiff did according to his own judgment. While there was evidence that the levers of the other switches were from 6 to 8 inches longer than the one in question, there was no proof that the lever in question was too short for the purpose for which it was used, or that it was defective in any respect, nor was it shown that the post was so near the track as to make it dangerous for the driver while performing his duties in the customary way; it appearing that it was dangerous only because plaintiff had lost his balance and, while swinging out over the car, came in contact with it. Held, that the accident was not one which could have been anticipated by a person of ordinary prudence, but resulted entirely from plaintiff's unexpected and unnatural position, and that negligence was not shown.—*Wallace vs. Columbia Coal Co., 166 S. W. 769.*

The Value of a Miner's Leg.—(Kentucky) An award of $1,000 in favor of a miner whose leg was broken, where he was confined for a month by reason of the break and one leg became shorter than the other, is not excessive.—*Big Branch Coal Co. vs. Sanders, 166 S. W. 813.*

Mine Operator Not an Insurer. (Missouri) A coal mine operator is not an insurer of the safety of the miners while they are being hoisted out of the shaft, and the mere existence of a defect in the hoisting cage is not sufficient to raise the inference of negligence on his part, without a showing of actual or constructive knowledge by the master of the defect.—*Ronchetto vs. Northern Central Coal Co., 166 S. W. 876.*

The Duty Imposed Upon a Mine Owner.—(Kentucky) Kentucky statutes, requiring mine operators to furnish props to miners, imposes on the operator of a coal mine the peremptory and non-delegable duty of furnishing such props to miners as are necessary to make the roof of the miner's working place safe when request is made therefor, and the miner, who is injured by the operator's failure to perform such duty, may recover damages for the injury sustained, unless the danger of the working place where he was injured without the props was so imminent and obvious that an ordinary prudent person would not have continued to work.—*Continental Coal Corporation vs. York, Adm., 167 S. W. 131.*

The Sale of Mineral Rights. (Texas) The law involving a question of the validity of a contract for the sale of mineral rights, is discussed to some extent by the Texas Court of Civil Appeals, in Whited *vs.* Johnson, a case which originated in the District Court of Harris County, Texas, and was sent to the higher court for review. The facts are that Johnson, the plaintiff, sued Whited to recover from him a balance of $5,356 on a contract by which Whited and others bound themselves to pay Johnson the sum of $10,000 for "all of the oil, gas, coal, sulphur, and other minerals in and under" a certain tract of land in De Soto Parish, La., "that may be found by drilling and mining operation which may hereafter be conducted on said land with the right of ingress and egress at all times for the purpose of drilling, mining, and operating for said minerals." Whited, in his defense admitted the execution of the contract and payment made upon the same, but denied a further liability on the ground that the plaintiff, by the contract, sold to him all of the oil, gas, coal, and sulphur contained on the property, which property as a matter of fact was found to contain no minerals. A further ground denying liability on the part of Whited was that the contract obligation had been destroyed by his having failed to dig for coal or sulphur, his operations having been confined to drilling for oil.

The Court of Appeals, in affirming the judgment of the District Court in favor of Johnson, said that the defendants were mistaken as to the contents of the land which they became interested in. They expected to find minerals and were disappointed. In view of their disappointment they attempted to breach the contract. This the trial court very properly prevented them from doing. The contention that a contract of sale of oil, gas, and other minerals contained under the land is not valid for the reason that they are not susceptible of indentification is unreasonable. As to Whited's contention that the contract obligation had been destroyed by his having failed to dig for coal or sulphur the court said: "A contract for sale of all oil, gas, coal, sulphur, and other minerals, in and under a described tract of land, that

may be found by drilling and mining operations which may be conducted on the land," is valid. It is a contract of sale which the purchaser may not destroy by failing to drill or mine.—*Whited vs. Johnson, 167 S. W. 812.*

Injury Caused by Fall of Mine Roof.—(Pennsylvania) The question of injury to a miner working in a coal mine and the liability on the part of the mine owner or operator for such injury, is discussed in Peters *vs.* Vesta Coal Co., a case recently adjudicated in the Supreme Court of Pennsylvania. The plaintiff, Henry Peters, was injured by the fall of the roof of a room in which he was working in the defendant company's mine. He claimed that a short time prior to the date of the accident he had "complained to the defendant company that said roof of said room was improperly supported, in that the posts used were too short, and at that time defendant promised plaintiff to have posts of the proper length provided, and assured the plaintiff it was safe to go on working until such time as proper length posts were supplied, that plaintiff relied upon said promise and assurance, and continued to work in said room," and that his injuries were "caused through the negligence of the defendant company in failing to supply the proper posts or supports after promising to do so."

The mine in question was subject to the Bituminous Act of Pennsylvania (Pa. Laws 52) which provides in Section 1, of Article 6, that the mine foreman shall see that all dangerous roofs are "secured against falling," and that sufficient "props, caps, and timber of suitable size" are sent into the "working places of the mine" when required for that purpose; in Section 2, that every workman in want of props "shall notify the mine foreman" at least one day in advance, giving the length and number required, "but in cases of emergency the timbers may be ordered immediately;" further, "If from any cause the timbers cannot be supplied when required, the mine foreman shall instruct the workmen to vacate all working places until supplied with the timber needed"; in Section 6, "The mine foreman shall give prompt attention to the removal of all dangers reported to him and shall direct that each and every working place be properly secured by props or timbers"; in Section 1, of Article 7, "It shall be the duty of the superintendent, on behalf and at the expense of the operator, to keep on hand at the mine at all times, a full supply of all materials and supplies required to preserve the health and safety of the employes as ordered by the mine foreman and required by this act"; in Section 2, "The superintendent shall not obstruct the mine foreman" in the fulfilment of his duties; in Section 1, of Article 20, the miner shall examine his working place before beginning work and take down all dangerous slate, or otherwise make it safe by proper timbering the same before beginning to dig or load coal, and he shall at all times be very careful to keep his working place in safe condition during working hours," and Rule 13, of Article 20, "Should he at any time find his place becoming dangerous, either from gas or roof, he shall at once cease working."

The contention of the plaintiff was that the evidence produced at the trial of the case was sufficient to bring the case within the authorities which rule that, under certain conditions, where the defendant has knowledge of the dangerous condition of a mine, and fails to remedy it, he can be held liable in the event of an accident.

The court, however, in holding for the defendant mining company, said: "The testimony makes it plain, beyond any reasonable doubt, that on the morning of the accident the plaintiff had full knowledge and appreciation of the obvious and imminent dangers of his position, and did not rely on the supposed superior judgment of the superintendent of the mine, or on the latter's promise to supply him with the required timbers; in fact, he did not even go so far as to assert in his testimony that he so relied. This is a clear case of one with knowledge and appreciation of danger taking a chance and getting hurt." Judgment for defendant.—*Peters vs. Vesta Coal Co. 90 A. 65.*

Excessive Damages for Injury. (Missouri) Plaintiff, a miner, broke his leg, split his knee, and injured his rib, making it necessary for him to remain in bed 2 months, and leaving him with a permanently disabled leg, which was painful, a habit of spitting blood from a permanent injury to his rib, and inability to ever again follow his occupation as a miner. He was 53 years old and married when injured. Two physicians testified that the action of his kneejoint was gone, and that the rib had loosened from its attachments, causing acute concussion of the left lung and intense pain. Held, that a verdict allowing him $12,000 was excessive and should be reduced to $7,000.—*Domineck vs. Western Coal and Mining Co. 164 S. W. 567.*

Liability of Lessee Under Mining Lease.—(West Virginia) A person having the right to go upon another's land "to bore and develop said land for oil and gas, with the necessary usual and convenient rights" therefor, has the right to build a road over the land, when necessary to haul machinery and material to the place selected for drilling a well. But if, after building the road, he abandons the contemplated exploration for oil and gas, before drilling a well, he is liable for injuries to the land, caused by the building of the road, notwithstanding the land owner has no interest in the oil and gas under his land.—*Coffindaffer et al. vs. Hope Natural Gas Co., 81 S. E. 966.*

The last annual report of the Pennsylvania Department of Mines states that there are in use at the bituminous coal mines of Pennsylvania, 43,355 safety lamps of seven different makes, all of which have been approved by the department. Of the total, 34,109 are Wolf lamps.

NEW MINING MACHINERY

Rope Retarding Conveyer

The Elkhorn Mining Corporation, at their No. 301 mine, have installed a retarding conveyer 372 feet long on a slope of 26 degrees. The head-house at the top of the incline is arranged with a cross-over dump and kick-back, the mine cars being discharged into a hopper. Coal will not run well on a 26-degree slope, but if it has a good start it will run over iron on a 28-degree slope; however, it does not start easily, when once stopped on a 28-degree slope, for which reason it is advisable to use from 30-degree to 32-degree pitch. On a pitch of 30 degrees and 372 feet long there would be a fall of 166 feet vertical, and this would furnish so great speed that coal would be badly shattered and degraded by the time it reached the loading shed at the foot of the plane. To prevent this on steep pitches and to cause the coal to move uniformly on pitches under 30 degrees, retarding conveyers are about as useful as any other method of lowering coal so far devised. At this particular plant the Fairmont Mining Machinery Co. have installed in the buildings shown in Fig. 1 a rope and button retarding conveyer shown in Fig. 2. The photograph for Fig. 2 was taken so as to look down the chute from the center of the vertical curve, and it shows the 1-inch diameter rope, with the 12-inch diameter disks spaced at regular intervals to move the coal down the chute at a speed the rope travels. Both the head- and foot-sheaves are of the flexible tooth type designed for this service and are arranged to grip the rope rather than the disks, but they can accommodate the disk if occasion should warrant. The coal from the tipple hopper is passed by a reciprocating feeder to the conveyer at the rate of 250 tons per hour. While gravity is of assistance in driving the machinery, the pitch is not sufficiently steep to overcome the sliding friction, much less perform the other work, consequently a 20-horsepower motor is installed to drive the equipment.

Fig. 1. Retarding Conveyer at Mines of Elkhorn Mining Co.

Fig. 2. Rope and Button Conveyer

The Fairmont Mining Machinery Co. have made similar instalments at mines 303, and 304, for the same coal company, showing that this system is satisfactory.

An Automatic Slate Picker

The Delaware & Hudson Coal Department has installed in its new Marvine washery near Scranton, Pa., a number of Mason & Allen slate pickers, as shown in Fig. 3, which attain an efficiency of 98 per cent. in cleaning the coal.

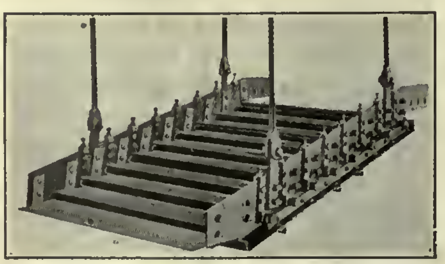


Fig. 3. Mason & Allen Slate Pickers

The picker is attached to the discharge end of a shaking screen and supported by hangers from overhead beams. The picker naturally moves at the same rate as the screen, which is usually a 5-inch throw at the rate of 155 revolutions per minute. The picker is made wide enough to fit the screen desired. Its separate plates are 8 inches in width and set at 7-inch

centers, which allows a half-inch overlap and underlap of the horizontal pipes at each edge.

Each pipe or cylinder has a separate and independent action aside from the shaking motion. It is held in place by a steel rod through its entire length. The size of the rod varies with the pipes. A $\frac{3}{4}$-inch pipe is used with a $\frac{9}{16}$-inch rod for buckwheat coal, for pea, chestnut, and stove sizes an inch pipe with a $\frac{3}{4}$-inch rod, and for egg coal, a $1\frac{1}{4}$-inch pipe and a $\frac{7}{8}$-inch rod. The remaining space in the pipe is filled with lead, but not enough to bind the rod. Should the rod ever become fastened to the pipe, the latter could still move owing to the fact that the rod rests in bearings at each end. The lead weights the pipe, but does not prevent it from swinging on the rod. It is this swinging that provides for an even distribution and good separation. Naturally when the picker is at rest the opening between any pipe and the plate directly beneath is less than at the end of the swing owing to the eccentric pivoted pipe. These openings vary according to the coal being prepared by that particular picker. The maximum and minimum openings for the different sizes are:

	Inch
Buckwheat	$\frac{2}{16}$ to $\frac{4}{16}$
Pea	$\frac{4}{16}$ to $\frac{5}{16}$
Chestnut	$\frac{5}{16}$ to $\frac{7}{16}$
Stove	$\frac{7}{16}$ to $\frac{9}{16}$
Egg	$\frac{5}{16}$ to $\frac{11}{16}$

The rock and slate being heavier than the coal, moves slower on the picker and consequently falls near the pipe at the upper edge of each plate. When the picker makes a back stroke with the screen the pipe swings forward, spreading out any small piles of the refuse within its radius, then on the forward stroke the refuse naturally goes the opposite direction and the pipe also swings back, allowing the rock and slate to pass through the opening and fall into a chute below.

The machine was designed primarily for flat refuse, so common in the anthracite region, and is strikingly simple in its design and operation.

The "Little Tugger" Hoist

A new kind of hoist is being marketed by the Ingersoll-Rand Co., 11 Broadway, New York City. It has a lifting capacity up to half a ton and, as it weighs under 300 pounds complete, it is particularly suitable for use as a portable hoist for mines, power houses, timber yards, and shops. It is used at mines for raising and lowering timbers and miscellaneous material, for hauling cars, for hoisting and lowering materials in shallow shafts, and for placing light machinery and for numerous other purposes.

Fig. 4. "Little Tugger" Hoist

The main base of the hoist is arranged so that it can be bolted to a timber, and by means of a cap which comes with the hoist it can be clamped to a drill column arm. The adjustment can be made quickly. The dimensions of the hoist are $21\frac{1}{4}$ in. × $16\frac{1}{2}$ in., and the height is $20\frac{1}{8}$ inches. The drum is 6 inches in diameter with a space of 7 inches between flanges. This will accommodate a length of 700 feet of $\frac{1}{4}$-inch rope or 450 feet of $\frac{5}{16}$-inch rope.

Fig. 5. "Little Tugger" at Work

The engine which operates with either compressed air or steam has a reversible or square piston, giving four impulses per revolution. There are no dead centers and the hoist will start in any position. The drum mounted on an independent shaft is operated through the medium of a clutch and gears. Safety is provided for by a powerful worm-operated band brake lined with "Raybestos."

Fig. 4 shows the "Little Tugger" hoist, the engine is on the right. The lever on the left controls the gears and clutch, the one on the right controls the machine and the bottom lever operates the brake. When the operator releases the throttle it returns automatically to the central position, shuts off the power, and stops the hoist. If the hoist is used for haulage purposes the release feature enables one man to handle the work. He can leave the control lever and carry the rope to the car. Hoists without this feature require two men, inasmuch as the rope has to be released under power.

Fig. 5 shows the machine in operation at a shaft, where, as shown, it is fastened to one leg of the headframe and operated by one man.

There are no moving parts exposed on the hoist, except the drum, all gears and shafts being covered. This is an especially desirable feature for underground operation where owing to poor light there is constant danger of workmen's clothes or bodies getting caught in the machinery unless it is carefully covered.

Woodward Iron Co.'s Electric Hoists

By L. F. Mitten

Over a year ago the Vulcan Iron Works, of Wilkes-Barre, built two electric hoists, for hauling cars on a mine slope having a total length

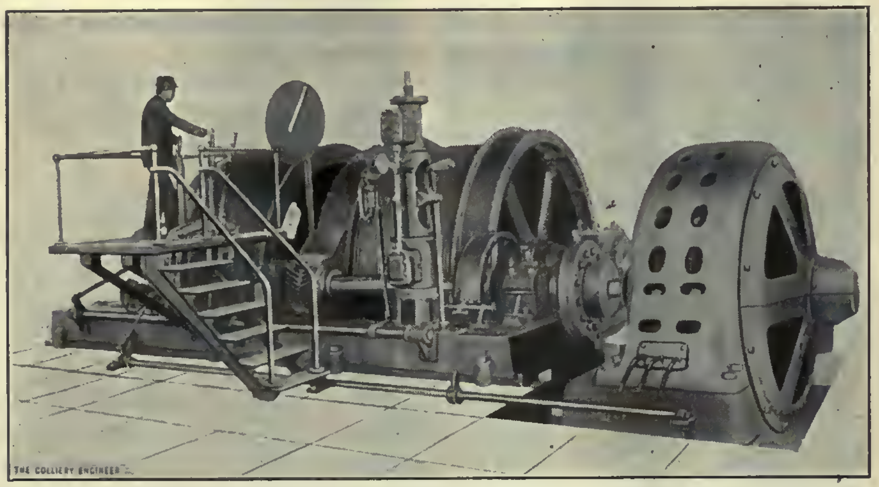


Fig. 6. A 700-Horsepower Electric Hoist, Made by Vulcan Iron Works

of 3,300 feet. One hoister of 500 horsepower is placed inside the mine, and pulls cars from the foot of the slope to within a distance of approximately 1,800 feet from the mouth of the slope. The cars are then dumped and the material reloaded into cars that are handled by the 700-horsepower hoister, which is on the surface. The maximum load as handled by the inside hoist is 20 tons, the maximum pitch of the slope being 30 degrees. The drum is geared for a rope speed of 500 feet per minute but is arranged so this can be increased to 800 feet per minute. It is driven by a 500-horsepower, eight-pole, 375-revolutions-per-minute, 3,300-volt, three-phase, 25-cycle, General Electric motor. The control equipment is a liquid rheostat with magnetically operated oil-immersed contactors. The drum, 7 feet 6 inches in diameter, is equipped with two asbestos-lagged brakes, each brake being of sufficient power to hold the load of 20 tons on the 30-degree slope. The drum is driven by a Lane band frictional clutch, which is thrown in and out by means of an air cylinder. One brake is operated by hand, while the other is a combination air and hand operated brake. The drums, main gear, base plate, and, in fact, all parts are sectionalized for easy transportation and assembling inside the mines.

The 700-horsepower hoist, Fig. 6, is geared for a rope speed of approximately 1,800 feet per minute and handles the following load on a 30-degree slope: Weight of cars and load, 63,600 pounds; weight of load, 33,600 pounds; diameter of rope, 1½ inches; weight of car, 30,000 pounds. This load, counterbalanced by a 45,000-pound weight, is operated on two-part rope and will therefore have a total travel of about 900 feet. The two 10-foot-diameter drums are grooved to coil 1,800 feet of 1½-inch wire rope in two layers. At a full load speed

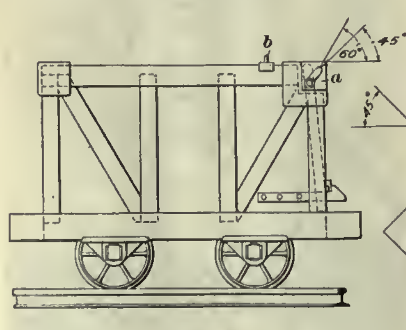


Fig. 7

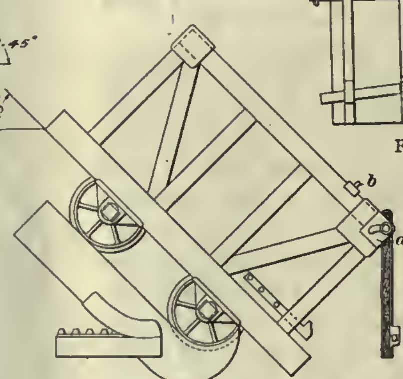


Fig. 8

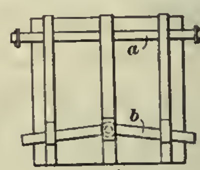


Fig. 9

the motor makes 290 revolutions per minute, and transmits power to the drum shaft by means of single reduction cast-steel, herring-bone gears. The motors are connected to the countershafts by means of flexible couplings. Each drum is equipped with an extra heavy band brake, one of the drums being operated by a weighted steam cylinder. Auxiliary hand brakes are also provided. The weighted brake is of the floating lever type, which permits of the band being applied partially or set up tight, as may be desired. It is therefore possible to regulate the pressure on the band, allowing the drum to revolve as slowly as may be desired. This hoist is equipped with the usual safety devices, which will bring the hoist to a dead stop should the operator pull into the danger limits. In case of failure of power supply, the hoist would also be brought to a full stop. All of the auxiliaries are operated by power cylinders, which are supplied by motor-driven air compressors located in the hoist house. This hoist is driven by a General Electric, 700-horsepower, 10-pole, 3,300-volt, three-phase, 25-cycle induction motor, and controlled with liquid rheostat and magnetically operated oil immersed contactors.

Automatic Car-Door Opener

*By C. W. Stickler**

The following is a description of a newly devised attachment for a mine car door whereby it is unlatched automatically as the car dumps. An experimental car has made over 100 trips from mine to dump and has

*Lansford, Pa.

never failed to do all that was expected of it.

The door arrangement is so simple it would appear as if there should be some mechanical arrangement to lift the latches; there is none, however, the latches being automatically worked by the movement of the door as the car is tilted on the dump. Fig. 7 shows a side view of the car. In the upper right-hand corner there is a casting *a* containing a slot which at the bottom two-thirds has a pitch of 60 degrees to give a grip to the door hanger; and at the upper one-third has a pitch of 45 degrees, so that the hanger rod may slide as the car is tilted as shown in Fig. 8. The latches are of the camelback construction, but are not extended beyond the sides of the car. Fig. 9 shows construction of the car door and the position of the hanger bar *a* and the latches *b*.

The operation which causes the gate to open is described as follows: When the car is tilted on the dump to the second, or 45-degree pitch of the casting, the car comes to a stop, and the momentum of its contents forces the upper part of the gate to move and with it the bar in the 45-degree pitch which is now parallel to the chute. The movement is first upwards and this raises the latches, and next outwards so the coal can slide into the chute from the car.

In order to prevent the spread of the car sides coming on the door hanger there is a cross-bar *b*, Figs. 7 and 8, placed about 18 inches back from the end of the car in such a position that it will be impossible for the upper part of the sides to spread and thus cause the door hanger to bind in the slot.

After the car becomes empty and the cradle returns toward the horizontal with the car, the gate drops, the latches strike the catches, and lever like raise and then fall into their slots. The advantages of this gate with its automatic arrangements of opening and closing are so apparent no further description is needed.

New Weston Instrument Transformers

Instrument transformers should be made with a much greater refinement than commercial lighting and power transformers, and these new contributions to electrical measurements by the Weston company are standards of excellence.

Of the two different portable current transformers listed, one has

FIG. 10. WESTON PORTABLE CURRENT TRANSFORMER

three self-contained primary windings, and the other is of the inserted primary type, the ratio depending upon the number of turns of the primary that are passed through the aperture.

There is also a portable potential transformer which is made in various ranges.

The switchboard models vary in appearance with the ratio, the volt-ampere capacity and with the potential of the circuit.

The manufacturer emphasizes the point that the ratios of transformation, and the design and proportions are such that it is unnecessary to have instruments specially calibrated with the transformers in order to obtain the degree of accuracy to which high-grade instruments are guaranteed when used without transformers.

This feature is of interest because the impression has prevailed that no transformers could be made that would assure the degree of accuracy for which a high-grade portable instrument is designed, unless special precaution had been taken to calibrate a particular instrument with a particular transformer.

TRADE NOTICES

The Fairmont Mining Machinery Co., of Fairmont, W. Va., is installing for the Carbon Coal Co., Carbon, W. Va., a rope and button retarding conveyer to have a capacity of 200 tons of coal per hour. The incline is 1,410 feet long and has a slope of 30° 30′. At the head-end is a picking table where the refuse is removed before the coal starts down the incline. At the loading shed, shaking screens and loading booms are to be furnished by this company, thus completing a thoroughly up-to-date equipment. The company is also installing for the Republic Coal Co., which is controlled by the same people as the Carbon Coal Co., a complete shaker-screen equipment—including picking tables and loading booms. It is also installing an improved river tipple equipment for the Winnifrede Coal Co., at Winnifrede, W. Va. This consists of a pan conveyer for carrying the coal from the mine to the river where it is loaded into barges by a pan conveyer, loading boom, and distributing chute, which is an improvement over anything in this line which has ever been installed.

Roofing.—The Eighth Coast Artillery will have an armory 375 ft. × 600 ft., at Jerome Avenue and Kingsbridge Road, New York. Its roof arches will have the greatest span in the world and the roof is to be covered with J-M asbestos roofing.

Combined Pocket and Level.—The Lufkin Rule Co., of Saginaw, Mich., is introducing a new practical tool. This is a 2-foot boxwood rule, similar to the ordinary carpenter's rule, but having a spirit level set into the upper edge of the middle section, where it is convenient for use and securely protected by the two outer sections when folded. Specially designed closing pins hold the rule in

alinement, insuring a perfect bearing surface.

Goulds Mfg. Co.—Announcement has just been made of the appointment of Mr. A. H. Whiteside as vice-president and general sales manager of the Goulds Mfg. Co., of Seneca Falls, N. Y. Mr. Whiteside succeeds Mr. W. E. Davis, who has been obliged to give up some of his active duties due to injuries sustained several months ago.

New Officials.—At a meeting of the Board of Directors of the Westinghouse Electric and Mfg. Co., on August 26, Mr. Henry D. Shute was elected treasurer to succeed Mr. T. W. Siemon, who recently resigned to accept the position of secretary-treasurer of the Union Switch and Signal Co., Swissvale, Pa. Mr. Truman P. Gaylord, district manager of the Electric company, at Chicago, was elected acting vice-president to succeed Mr. Shute.

Correction.—In the August issue of The Colliery Engineer, it was stated on page 32 that a pair of Litchfield hoisting engines was equipped with a Welch overwinding device. This is wrong: the engines are equipped with a device known as the Litchfield automatic stop.

New Building.—The Toledo Pipe Threading Machine Co., of Toledo, Ohio, are just completing a factory and office building that will not only enable them to turn out their product with the utmost efficiency, but has been designed to be especially comfortable for the men. It is about 120 ft. x 160 ft., saw-tooth roof construction, and one story high, except in the front where it is carried up two stories, the second floor being utilized for office room and for a welfare room for the men. The shop is built of steel, glass, and tile; and the front, or two-story portion of the building, is carried up in tapestry brick and concrete. The offices will be finished in mahogany, the receiving and shipping departments down-stairs in oak. An interesting fact in connection with this building is that it is located on the lot which contained the old Chief Justice Waite home; in fact, the old brick mansion was torn down to make room for the new factory.

The Link-Belt Co. has recently closed a contract with the Allegheny River Mining Co. to erect a large tipple across the river from Logansport, Pa., where a new mining town is being built on an extension of the Pittsburg & Shawmut Railway from Kittaning to Freeport. The coal will come from the mine in trips of 30 to 40 cars, where it will be dumped into hoppers and by means of feeders delivered to two inclined apron conveyers running parallel to each other, the top section of the apron conveyer running horizontal for a distance of 20 or 30 feet to afford ample picking surface for the men. Here the coal will be delivered to shaking screens, where It will be sized, and from the screens it will go to loading booms, which will deliver it to the railroad cars. The entire outfit is to be of steel construction, and of the latest design.

Catalogs Received

J. C. Stine Co., Tyrone, Pa. The J. C. Stine Patented Disc Fans, 24 pages.

Robinson Ventilating Co., Pittsburg, Pa. The Turbine Fan, 39 pages.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Ingersoll-Rogler Valves for Air Compressing Cylinders, 27 pages; Ingersoll-Rogler Class ER-1, 20 pages.

Ruby Co., Jackson, Mich. Ruby All-Steel Sectional Buildings, for Railroad Purposes, 11 pages.

Lagonda Mfg. Co., Springfield, Ohio. Lagonda Multiple Strainers, Catalog R-2, 20 pages.

Nordberg Mfg. Co., Milwaukee, Wis. Bulletin No. 24, Nordberg Electric Hoists, 23 pages; Bulletin No. 25, Steam and Air Hoists, 30 pages.

Western Electric Co., 463 West Street, New York, N. Y. Magnetic Telephones and Supplies, 40 pages.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 82, Liquid Level Gauges, 19 pages; Bulletin No. 88, Recording Gauges for all Purposes, 31 pages.

National Tube Co., Frick Building, Pittsburg, Pa. N.T.C. Regrinding Valves, 7 pages.

Chicago Pneumatic Tool Co., 1014 Fisher Building, Chicago, Ill. Ideal Power, 63 pages.

Weston Electrical Instrument Co., Newark, N. J. Bulletins of Portable Alternating-Current Instruments and Accessories,. 14 pages; Bulletins of Switchboard Instruments and Accessories for Alternating Current, 25 pages.

Harris-Stevens Co., First National Bank Building, Pittsburg, Pa. Circular, Modern Mine Cars; Circular, Centrifugal Mine Fan.

Sanford-Day Iron Works, Knoxville, Tenn. Circular, Heavy Duty "Whitney Wonder" Roller Bearing Wheels.

National Transit Co., Oil City, Pa. Pumping Machinery, 15 pages.

Kennedy Valve Mfg. Co., Elmira, N. Y. Catalog and Price List, 1914, 123 pages.

Titan Storage Battery Co., Chapel Street and Lister Avenue, Newark, N. J. Titan Storage Batteries, 31 pages.

Easton Car and Construction Co., Easton, Pa. Catalog No. 508, 52 pages.

Precision Instrument Co., 102 Randolph Street, Detroit, Mich. Bulletin G-3, Standard Apparatus for Analyzing and Estimating the Heat Value of Solid Fuels, 7 pages; The "Precision" Patent Water Meter 4 pages; Bulletin O, Wright's Improved Orsat Apparatus, 4 pages; Precision Simmance-Abady Patent Combustion Recorder, 16 pages; Precision Recorders and Indicators, 23 pages.

L. J. Wing Mfg. Co., 352 West 13th Street, New York, N. Y. Bulletin No. 28, Fans, Motor, Turbine and Belted, 20 pages.

The Wasson Coal Co., near Harrisburg, Ill., has a Giubal fan in a concrete fan house. It looks neat and is fireproof.

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The Colliery Engineer

Formerly Mines and Minerals

XXXV—No. 4 NOVEMBER, 1914 Scranton, Pa.

First-Aid Contests, 1914

Exhibitions and Contests in Various Parts of the Country Showing the Extent to Which the Movement Has Developed

Written for The Colliery Engineer

A NEVADA mine-rescue and first-aid contest, which was novel in several respects, was held on the Mackay Athletic Field of the University of Nevada, at Reno, Nev., on Labor Day, September 7, 1914. It was the first strictly metal mining contest to be held in the United States.

The contest was held under the auspices of the Engineering College, with the cooperation of the United States Bureau of Mines, the American Red Cross Society, and the Nevada Industrial Safety Association. The miners who participated in this meet had been trained by E. Steidle, mining engineer, and George W. Riggs, first-aid instructor attached to Mine-Rescue Car No. 5 of the United States Bureau of Mines. This car had been touring the state of Nevada since July 1, and those in charge of it had trained 69 miners and 10 students of the University of Nevada in mine-rescue work; also 130 miners and 15 students in mine first-aid work, besides holding lectures which were attended by 4,400 Nevada miners.

The model drift which was employed in the mine-rescue maneuver was designed by Mr. Steidle. It was 260 feet in length and constructed of timber, laths, and tarred paper with the side toward the grandstand left open throughout its length, save for one section which was closed with doors and windows so it could be filled with dangerous gases. The model consisted of 80 feet of open drift followed by 20 feet of drift only 3 feet in height, in which a hanging fall was supposed to have taken place. Beyond this came 20 feet more of open drift, succeeded by a gas and smoke chamber, which was 40 feet in length and had an inclined obstacle in the middle. At the further side of the gas and smoke chamber were 20 feet of open drift followed by 200 feet, representing a fall, in which there was a 3-foot opening above the fall, and finally came 60 feet more of open drift to the face.

First-Aid Contest at Reno, Nevada, Showing Model Mine Drift

The participants in the mine-rescue maneuver were examined by

physicians, then tested and adjusted their apparatus, and stood a 3-minute trial in a small test house filled with gas and smoke. Each team in turn then entered the model drift and rescued a miner, supposed to have been overcome near the face of the tunnel. A stretcher and breathing apparatus were carried into the mine for the use of the injured man and the team carried a life line and took all the precautions as suggested by the United States Bureau of Mines.

Four teams competed, the first prize being won by the Tonopah Mining Co.

The problem in the first-aid contest was to apply first aid to a miner found in a drift under a fall of rock, and in contact with an electric wire. The patient was supposed to be unconscious, to be suffering from an electrical burn and numerous injuries, and the teams were given 25 minutes in which to perform the work. Seven teams competed, the first prize being won by the team from the McGill Concentrator of the Nevada Consolidated Copper Co. Three teams of students from the University of Nevada also contested amongst themselves.

The first prizes were a silver shield and a silver loving cup, presented by the Nevada Industrial Safety Association to the winning teams, while medals were presented to the individual members of these teams by the American Mine Safety Association. The other prizes distributed at the meet included subscriptions to The Colliery Engineer and other technical papers, contributed by the publishers, and miners' lamps donated by the manufacturers.

Broken Back Splint, Back View

Broken Back Splint, Front View

Delaware, Lackawanna & Western

On August 22, the Delaware, Lackawanna & Western R. R. Co. held their annual first-aid contest at Sans Souci Park, near Wilkes-Barre. Thirty-four teams were entered, eight from the Transportation Department and twenty-six from the Mining Department, comprising in all 175 men.

The contest was under the direction of Dr. J. M. Wainwright, chief surgeon of the D., L. & W. Co., who was aided by the following judges: Dr. W. A. Moore, Binghamton, N. Y.; Dr. D. H. Keller, Bangor, Pa.; Dr. George M. Cady, Nichols, N. Y.; Dr. H. F. Smith, Scranton, Pa.; Dr. D. H. Lake, Kingston, Pa.

All the teams contested in the first round, which consisted of seven events, covering the treatment of a great variety of injuries, and the work was uniformly of a very high order. The contesting teams were arranged on the field in five rows with a judge for each row, and of the highest teams in each row the following were chosen to contest in the second round:

For the championship of the Mine Department and the Superintendent's Cup, Central, Taylor, Bliss, Storrs No. 2, and Brisbin. The Central team, Joseph Taylor, captain, was the winner, taking the Superintendent's cup from the Brisbin team, which was the winner last year.

For the championship of the Transportation Department, two teams contested, the Foundry and the Machine Shops. The Foundry team, T. Harding, captain, was the winner, holding the Championship cup, presented by the R. R. Y. M. C. A., for the third consecutive year. There were five events.

Between the second and third rounds, there was an exhibition by the Bellevue team of the use of a special splint designed by Dr. H. F. Smith, of Scranton, for handling a man with a broken back. A back and a front view are shown herewith, and a description and drawings showing construction are given on another page.

The third round was for the President's Cup and the championship of the entire system. This contest was between the two winning teams: Central and Foundry, and was won by the Foundry, who also won the cup in 1912, but lost it last year to the Brisbin team.

Foundry Team, D., L. & W.

Central Team, D., L. & W.

The third round consisted of five events, and of these Nos. 2 and 5 were novelties.

Carrying a Man Down a Chute

No. 2 was: A man is under a piece of fallen rock 10 feet square. He has a broken back. Prop up piece of coal with two props 3 feet high. Man must be removed, treated, placed on improvised stretcher and carried 50 feet.

The piece of rock was represented by a wooden frame and the problem was interesting from its realism.

No. 5 was: Man injured at top of slope. Lacerations of scalp. Lacerations of leg midway between knee and ankle. Unconscious. Dress, carry down slope and take to post. No stretcher, carrying all by hand.

The interesting feature of this was the method of bringing the man down the slope which had been built in the grandstand and lined with iron. Two methods employed in handling the patient are shown, in one the patient being laid on the back of one member of the team, who serves as a sled while sliding down the chute.

The contest was attended by a large number of officials of the company, among whom were C. E. Tobey, superintendent of the Coal Department, and T. E. Clark, assistant to the president, who gave the prizes to the winners.

On September 8, the Central team went to New York City to attend the exhibit of the American Mine Safety Association.

The Midlothian colliery fire, in Virginia, which caught in the early part of the last century, has cost a number of lives and large expenditures of money. At last accounts the fire was still raging.

Carrying a Man Down a Chute

The First-Aid and Mine-Rescue Meet at Seattle

*By G. W. Evans**

The first state-wide mine-rescue and first-aid meet was held on the campus of the University of Washington, on July 22 and 23, at Seattle, Wash. This contest was under the auspices of the United States Bureau of Mines with the cooperation of the State Mine Inspection Department, the coal operators of the state of Washington, and District No. 10 of the United Mine Workers of America.

The meeting was successful in every detail, the grandstand of the campus was comfortably filled with spectators from Seattle and the surrounding country, who, for the first time, saw the methods employed in mine-rescue work.

A model mine was laid out on the campus with its main and cross-entries, and a chute was built on an angle of 45 degrees. Also a smoke house was built so that poisonous gases could be generated within it. The helmet men during their exhibition entered the building and stayed there for a given period of time.

Thomas Graham, Chief Inspector of Mines of the Province of British Columbia, was the judge of the day. W. D. Ryan, of the United States Bureau of Mines, awarded the prizes and with Hugh Wolflin, of the same department, assisted J. J. Cory, who is in local charge of the Mine Rescue Station maintained by the Bureau of Mines. James Bagley, State Mine Inspector, represented his department. D. C. Botting, commissioner of the coal operators of that state, represented the coal companies. Martin J. Flyzik, president of District No. 10, United Mine Workers of America, represented his organization and it is through his good offices that the mine workers took an active part in the meet. The secretary was Mr. Jacbs, of Vancouver, B. C.

There were eight first-aid teams represented, one each from Cle Elum, Franklin, Issaquah, Black Diamond, Ravensdale, Beakmen, and two from Roslyn. There were five mine-rescue teams in which the following mining camps were represented: Roslyn, Black Diamond, Issaquah, Ravensdale, and Beakmen.

In the Mine-Rescue events the first prize was awarded to the Roslyn Fuel Co.'s team consisting of W. C. Shaw, captain, Thomas Wallace, James McGraw, Harry Taylor, and Ernest Taylor. The second prize was awarded to the team from the Issaquah and Superior Coal Mining Co.'s mine at Issaquah, consisting of John Parker, captain, M. Crossley, F. Roell, A. Thompson, and J. Jones. The third prize was awarded the Roslyn team, Walter Snedden, captain, Dan Shields, Tony Stanfel, Albert Bonette, John Graham, and James Boose.

In the first-aid work the Cle Elum team took the first prize in the team event, the Franklin team took second prize in the two-man event. The Issaquah team took two prizes. First prize in the two-man event, third prize in the team event. The Roslyn team took first prize in the four-man event and second prize in the one-man event. The Black Diamond team took second prize in the one-man event and first prize in the three-man event. The Roslyn Fuel team took second prize in the team event and second prize in the four-man event. The Ravensdale team took second prize in the three-man event.

Mr. Graham, in rendering his decisions stated that the work as a whole was exceedingly good. He made special mention, however, of the excellent work performed by the team from the Roslyn Fuel Co.'s mine.

It is expected that this will be a yearly occurrence and the various

Teams and Officials at First-Aid Meet, Held

*Seattle, Wash.

teams are looking forward to the meet of next year. The coal mine operators of the state of Washington deserve great credit for the interest they have taken in this very important phase of mining.

LIST OF EVENTS

First-Aid Contest, July 23:

No. 1. Team Event. Time, 20 minutes. Simple fracture of right thigh; fifth and sixth ribs on left side broken; compound fracture of right wrist with bright red bleeding, treat and carry 50 feet.

No. 2. One-Man Event. Time, 7 minutes. Miner is overcome by gas; remove 20 feet to fresh air and perform artificial respiration for 1 minute.

No. 3. Two-Man Event. Time, 8 minutes. Simple fracture of right forearm; right lower jaw broken.

No. 4. Four-Man Event. Time, 15 minutes. Patient overcome by powder smoke; right forearm broken; improvise stretcher and carry 100 feet.

No. 5. Three-Man Event. Time, 8 minutes. Head, face, neck, arms, and hands burned by gas ignition.

No. 6. Team Event. Time, 15 minutes. Miner caught between loaded car and rib, right shoulder blade broken; left arm broken 6 inches above elbow; left foot crushed; lacerated right cheek; improvise a stretcher and carry 100 feet.

No. 7. Two-Man Event. Time, 10 minutes. Flesh torn off back of left hand; compound fracture of right arm.

No. 8. Team Event. Time, 20 minutes. Compound fracture of right thigh with severe arterial hemorrhage, and compound fracture of left forearm. Treat patient and carry 100 feet.

Mine-Rescue Contest:

Team of five men, including captain, equipped with artificial breathing apparatus.

Recovery work after mine explosion caused by blown-out shot.

Miners rescued, carry to air; perform artificial respiration for 2 minutes; treat for burns on face, hands, and back.

First-Aid Contest, July 23:

No. 1. Team Event. Time, 20 minutes. Explosion of keg of powder, burning miner severely on face, neck, chest, back, and both arms; improvise stretcher and carry 100 feet. Treat patient.

No. 2. One-Man Event. Time, 8 minutes. Severe cut on forehead, right hand mashed.

No. 3. Two-Man Event. Time, 8 minutes. Man found lying with back across electric wire; remove from wire, treat for electric shock.

No. 4. Three-Man Event. Time, 10 minutes. Right knee-cap injured by fall of rock; left hand badly mashed; improvise stretcher and carry 50 feet. Treat patient for injuries.

No. 5. Team Event. Time, 20 minutes. Miner caught by flying coal from supposed missed shot. Right side of face badly cut; right eye blown out; simple fracture of right thigh; three lower ribs on left side broken. Treat and carry 100 feet.

No. 6. Team Event. Time, 20 minutes. Miner with severely injured spine; fracture of right upper arm; treat and carry through tunnel and over obstruction.

Exhibition event not to be considered in contest:

Two-Man Event. Miner going back into his chute too soon after firing a shot, is overcome by powder smoke; remove 20 feet to the gangway, and perform artificial respiration for 2 minutes.

A place to represent a chute was built on the ground and all teams were expected to take part in this event if called on.

Mine-Rescue Contest:

Team Event. Mine fire. Seal off fire and remove one of helmet men in distress; carry to fresh air and revive.

eattle, Washington—Chute Shown in Background

Team will consist of five men, one of whom shall be the captain.

LIST OF PRIZES—FIRST-AID CONTESTS

Team Events:

First prize: Silver cup and American Mine Safety Association (silver) and Red Cross medals; cup must be won at two consecutive state-wide meets to be retained by team.

Second prize: American Mine Safety (bronze) medals, American Red Cross certificates, and one Johnson and Johnson first-aid cabinet.

Third prize: Bauer and Black first-aid cabinet.

One-Man Events:

First prize: $4 cash.

Second prize: Two "Justrite" acetylene lamps.

Two-Man Events:

First prize: $5 cash.

Second prize: Three "Justrite" acetylene lamps.

Three-Man Events:

First prize: Three one-year subscriptions to *Coal Age*.

Second prize: $6 cash.

Four-Man Events:

First prize: Silver cup, to be retained by winning team.

Second prize: $5 cash and Baldwin mine lamps.

Prizes to be awarded on averages made in events for both days.

MINE-RESCUE CONTEST

First prize: Silver cup and American Mine Safety Association medals.

Second prize: Two Koehler mine safety lamps and three subscriptions to *Coal Age*.

Third prize: Five yearly subscriptions to THE COLLIERY ENGINEER.

FIRST-AID TEAMS

The first-aid teams were represented by the following men:

Cle Elum, No. 1, Thomas Summerill, captain, William Reay, E. E. Simpson, T. Barras, William Saul, Fred Ashhurst, subject.

Franklin, No. 2, James Carson, captain, Frank Zlinski, William Toman, Joe Stewart, Harry Irwin, Charles Mills, subject.

Roslyn, No. 3, Percy V. Wright, captain, S. R. Justham, A. G. Lindsay, John Heathcock, Matt Mohar, Ed Bowden, Jr., subject.

Issaquah, No. 4, J. Jones, captain, J. Parker, M. Crossley, G. Elenor, F. Roell, A. Thompson, H. Harris, subject, A. Neil, team manager.

Roslyn, No. 5, W. Sneddon, captain, D. Shields, M. Boose, Tony Stanfel, John Graham, Albert Bonetta, subject.

Black Diamond, No. 6, J. W. Upton, captain, M. A. Morgan, James McDonald, Gust Swanson, James Murphy, subject, Henry De Winter.

Roslyn Fuel Co., (Beakman) No. 7, Samuel McCulloch, captain, Robert Bell, Harry Taylor, Ernest Taylor, James McGraw, David Davis, subject.

MINE-RESCUE TEAMS

The mine-rescue teams were as follows:

Issaquah, No. 4, John Parker, captain, M. Crossley, F. Roell, A. Thompson, J. Jones.

Roslyn, No. 5, Walter Snedden, captain, Dan Shields, Tony Stanfel, Albert Bonetta, John Graham, James Boose.

Black Diamond, No. 6, Fred Ring, captain, M. A. Morgan, Joe McDonald, Gust Swanson, Henry De Winter.

Roslyn Fuel Co., No. 7 (Beakman), W. C. Shaw, captain, Thomas Wallace, James McGraw, Harry Taylor, Ernest Taylor.

Ravensdale, No. 8, T. J. Kane, captain, P. J. Dowd, Ed Seeley, Laurence Desmenti, T. D. Williams.

CASTLE GATE, NO. 2 TEAM, WINNERS OF FIRST PRIZE

CASTLE GATE, NO. 1 TEAM, SECOND PRIZE WINNERS

The Utah Fuel Co.

The first field contest of first-aid teams of the Utah Fuel Co., and the first of its kind ever held in the state of Utah, took place July 24 at the Castle Gate in the Price River Cañon. July 24 is a legal holiday in Utah, it being the anniversary of the settlement of the first Mormons in the Salt Lake Valley.

With 2,000 spectators present, 18 6-man teams, one boys' team, and two teams of young women from Winter Quarters competed.

First-Aid Contest, Utah Fuel Co.

The first prize was won by team No. 17 from Castle Gate No. 2 mine with 216⅘ points out of a possible 220. The award was the silver loving cup to be contested for each year until won three times by any one team. The members of the winning team are: R. J. Henderson, captain, John Ramage, James Wilson, Albert Wardell, James Lakin, and J. S. Hreimson.

Second prize was won by the No. 7 team of the Castle Gate No. 1 mine with 210⅘ points. The awards were pocket knives appropriately engraved. The team was composed of Jacob Jones, captain, H. Mather, John Yates, Frank Levis, James Cowan, and Herbert Walker.

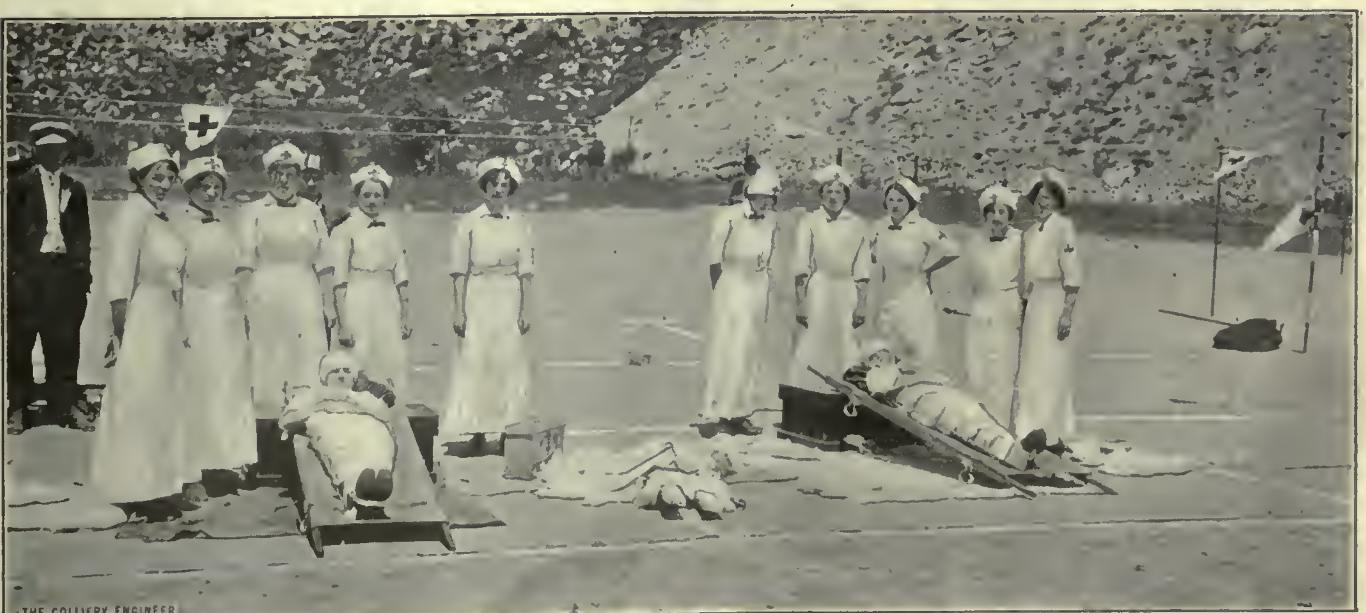
Gold medals were awarded to the winners of the separate events.

The first prize winner in the one-man event was E. H. Holland, of Sunnyside team No. 2. J. Palmer, of the No. 1 team won second prize. The first prize winners of the two-man event were E. Lloyd and H. Stubbs, members of Sunnyside team No. 1.

The second prize winners in the two-man event were Valentine Autzok and Roman Etzell, of Winter Quarters team No. 3.

The first prize winners of the three-man event were John Haddow, William Edwards, and Victor Bain, of Utah Mine team No. 1. Alex. Curtis, Anton Michlog, and Guest Jambelis, of Cedar Creek team No. 3, won the second prize.

The supervising judges were Messrs. Roberts and Lanza, of the Bureau of Mines. Dr. F. R. Slopanski, of the Denver & Rio Grande Railroad, Dr. James Dowd, Messrs. A. W. Dennison, and W. H. Sanderson, of the Consolidated Fuel Co.,



Women's Team, Winter Quarters—Utah Fuel Co.

and J. S. Thompson, of the Colorado School of Mines, were the active judges.

Philadelphia & Reading Field Day

On Saturday, September 19, the Philadelphia daily papers contained an item which read something like this: "On a special train which included the private car 'Reading,' E. D. Stotesbury, president of the Reading company and a large party of Reading officials left the terminal early in the morning for East Mahanoy Junction. Among the party were Theodore Voorhees, president of the Philadelphia & Reading Railway, B. J. Montgomery, W. G. Brown, George Zeigler, and several of the directors. The purpose of this trip was to attend the exercises of the first-aid and rescue corps of the Philadelphia & Reading Coal and Iron Co. and to witness the games conducted by the employes who were celebrating their annual field day."

No mention is made of the special train with three passenger cars containing about 200 waiters and the necessary baggage cars to convey food, table linen, crockery, and eating utensils necessary to supply the wants of 1,800 individuals; neither was anything said of the 200 or more prominent men being invited guests and who made the pilgrimage from every section of the state for the purpose of witnessing the events and the pleasure of seeing old and making new acquaintances; nor of the special trains from Shamokin, Shenandoah, Tremont, and Pottsville and special trolley service enlisted in the enormous undertaking of gathering men from almost every section of the Schuylkill region and conveying them to East Mahanoy Junction. Yet all this and more was necessary to carry out the program which had been arranged as a reward for the men who have given their time to the study and practice of first aid to the injured. Aside from the expense connected with the affair, the mental and physical labor involved in an undertaking of this kind can hardly be comprehended and could have only been carried out successfully by many individuals working along different lines, but all tending toward one harmonious end. But system is one thing which is preeminent in coal mining operations, and there is no industry that moves with the same exactitude in its various ramifications, nevertheless, all present must acknowledge the capability of the men who had this meeting in charge and whose names, it is believed, would include most of the officials of the Reading Coal and Iron Co., for they all joined in making the day enjoyable.

The invited guests were presidents of other coal companies, individual operators, mining engineers, mine inspectors, mine superintendents, ministers, priests, financiers, politicians, pensioners of the company, physicians from the coal fields, school superintendents, newspapermen, United States Bureau of Mines representatives, lawyers, civilians, and last year's winning first-aid team from the Susquehanna Coal Co. This aggregation made as cosmopolitan a gathering as it would seem possible to bring together. That such men should leave their affairs and attend a meeting of this kind, indicates clearly that they want to help both the men and the management of these concerns by their encouragement of a good cause. In no way is it possible for the officers of large corporations to come in contact with men under them except on occasions such as this, particularly where the various parts of the corporation are so widely separated as those of the Philadelphia & Reading Coal and Iron Co. and other large companies in the anthracite fields.

In outings of this kind, the conventional cloak which business imposes during working hours is cast aside by all, and it is believed that this mixing is productive of much benefit to officers and men alike, because they come face to face and form true opinions of each other, which not so long ago were er-

Bandaged for Burns, Philadelphia & Reading Coal and Iron Co. Contest

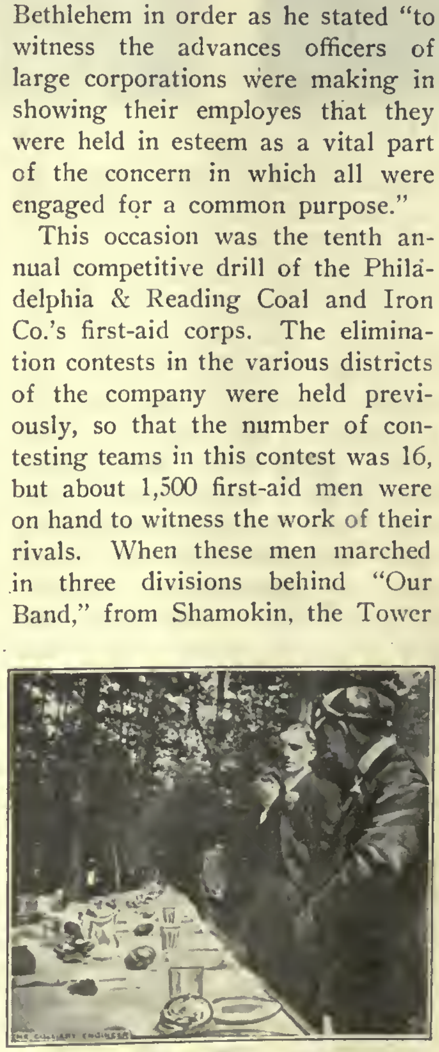
Bandaged in Final Event, Philadelphia & Reading Coal and Iron Co. Contest

roneously formed by each from a distance.

This was President Stotesbury's initial visit to a first-aid contest, and he was intensely interested in everything he saw, from the deft and rapid bandaging to the rescue corps wearing Draeger oxygen helmets in a smoke-filled room constructed for the purpose. On this occasion, President Richards, of the Philadelphia & Reading Coal and Iron Co., left his private car and guests in order that he might go alone through the excursion trains, meet the men individually, thank them for their helpfulness in making the day a success and for their endeavors in aiding him to help the injured. The men appreciated this, and as they watched his face when he greeted one after another they knew he was not dissembling, but was as loyal to them as one man can be to another, and that he was now visiting them as if they were his neighbors.

One of the most interested men in the large gallery surrounding the roped-off portion of the field in which the contests took place was Dr. Henry S. Drinker, president of Lehigh University. Doctor Drinker took the 6 a. m. train from South Bethlehem in order as he stated "to witness the advances officers of large corporations were making in showing their employes that they were held in esteem as a vital part of the concern in which all were engaged for a common purpose."

This occasion was the tenth annual competitive drill of the Philadelphia & Reading Coal and Iron Co.'s first-aid corps. The elimination contests in the various districts of the company were held previously, so that the number of contesting teams in this contest was 16, but about 1,500 first-aid men were on hand to witness the work of their rivals. When these men marched in three divisions behind "Our Band," from Shamokin, the Tower



P. & R. C. and I. Dinner

City Band, and the Elmore Band, of Shenandoah, they formed a regiment, and one could not but feel that they and the 40,000 more first-aid men in the coal mining districts of the United States would be as helpful in case this country was plunged in war as the men who carried the guns.

In the preliminary contests in the morning, Tunnel Ridge Inside came out ahead with a mark of 97 and Turkey Run Inside, Pottsville colliery (Primrose Section), and Maple Hill Inside, tied at 96. This left seven teams to compete in the final after dinner. In the final morning events, exhibitions were given of the pulmotor; Schaefer and Sylvester methods of artificial respiration; the lifting of injured men from the ground by individuals; two men lifting and carrying an injured man; and a four-man team lifting a man from the ground and placing him on a stretcher, carrying him to and putting him inside an ambulance.

The final problem which occurred after dinner was dressing a crushed foot, knee, leg, thigh, and hip with spiral reverse figure 8 spica using ten 2½-inch bandages. The conditions governing this contest were:

time allowance, 25 minutes; and "in the application of the spiral reverse bandage ⅓ of the width of the bandage was to be left exposed." The three judges on the occasion were Dr. T. C. Fegley, of Tremont, and Drs. A. J. Bauer and L. M. Knauber, of Pottsville. The work was so good that these judges were unable to come to a decision and five additional physicians were called into consultation. Eventually, Draper Colliery Outside was given first prize with a score of 98 per cent. Wadesville came second with a score of 97, and Tunnel Ridge third, with a score of 96.

Draper Outside Corps, P. & R. C. & I. Co.

Taylor Team, D., L. & W. Coal Co.

After the awards were announced, Judge Richard H. Koch, of Pottsville, made a short and effective speech in which he congratulated the winners and losers alike. President Richards then spoke briefly, expressing the wish that the deep interest shown in this work would continue so that next year new winners may come up. The awarding of the pennant and the prize ribbons was a pretty ceremony, the latter being pinned on the contestants by several young ladies from Pottsville.

After the decision had been rendered, the audience adjourned to witness the helmet crew's exercises. For this purpose, a small house had been erected with glass sides so that spectators outside could witness the movements of the men inside, but the smoke was so dense that the men could not see and could only find each other by groping.

The Philadelphia & Reading Coal and Iron Co. have 1,740 men trained in the use of rescue apparatus, and while they have at present 97 first-aid teams they have very many more than this trained in the art. Doctor Halberstadt has been engaged in training men for first-aid work a long time and he has reduced the teaching to a science. One feature which might be copied at similar meetings to advantage was dressing injuries by material furnished the men for the purpose; thus, covering the ground with first-aid kits and material which was unnecessary for a problem, was avoided. Each team working out a problem was handed the materials needed by an assistant of Doctor Halberstadt and after the problem had been finished they were returned to the assistant.

To handle the 1,800 people who sat down to dinner, they were formed in fours and marched to the oak grove, which has a slight slope. Beneath the trees were step-like rows of long tables with benches for the diners' seats. The tables were covered with snowy damask and the service was all that could be desired. As the men marched into the grove, aids directed them to the tables in the order in which they arrived, so that the 1,800 were quickly seated. The waiters served the food in courses with no more disorder than would have occurred in a well-regulated hotel dining room. In fact, no soup was spilled and no dishes broken. It was a course dinner from soup to ice cream and coffee.

The writer circulated among the men, talking to those with whom he came in contact without the formality of an introduction. All his advances were received with courteous remarks, so that he can truthfully state that there was a feeling of good will and peace among all gathered at this outing. There were to have been field sports and water sports, but outside of the base-ball game and a little singing at the station there was not time enough for athletic contests. About 5 o'clock the guests entrained and left, as they came, without fuss, haste or commotion, and thus ended an outing which will be long remembered by those who had the pleasure of being in attendance.

The Lehigh Valley led in anthracite tonnage in June with 1,325,982 tons; the Philadelphia & Reading was second with 944,816 tons; and the Lackawanna was third with 941,868 tons. The Central Railroad of New Jersey carried 839,514 tons, the Erie 738,175 tons, the Delaware & Hudson 661,248 tons, the Pennsylvania 470,652 tons, and the New York, Ontario & Western 207,931 tons.

Inter-Company Red Cross Contest

On September 19 the annual inter-company Red Cross first-aid contest was held in Valley View Park, Inkerman, Pa.

The 18 teams entered represented 10 different anthracite companies. The prize sought was the cup presented by Mrs. John S. Muckle in 1909, which is contested for yearly until it becomes the property of the team winning it three times. There were also Red Cross medals for the members of the winning teams and Red Cross certificates for the members of the three teams that tied for third place.

The judges were Dr. S. S. Shields, chairman, Dr. M. L. Bailey, Dr. J. W. Grant, Dr. J. G. Singer. The managers were Dr. M. J. Shields, of the American Red Cross, C. E. Tobey, general manager, D., L. & W. Coal Co., F. H. Coughlin, secretary, Pennsylvania Coal Co.

The rules of the contest were those that have been adopted by the American Mine Safety Association, and Dr. M. J. Shields of the American Red Cross, chairman of this contest, expressed the hope that these rules might be generally adopted, as then it would be possible to compare the work of teams competing in different parts of the country. For the convenience of those interested, the rules and plan of marking are given herewith:

JUDGES AND OFFICIALS AT INTER-COMPANY CONTEST

LACKAWANNA OUTSIDE, WINNERS INTER-COMPANY CONTEST

DISCOUNTING TABLE

Problem:

Judge's report............. First-Aid Contest

Event No........... Team No...........

1.	Not doing the most important thing first	5..
2.	Failure of captain to command properly	2..
3.	Slowness in work and lack of attention	4..
4.	Failure to entirely cover the wound or ignorance of location of injury	4..
5.	Ineffective artificial respiration	10..
6.	Splints improperly padded or applied	2..
7.	Tight, loose, or improperly applied bandages	6..
8.	Insecure or "granny" knot	5..
9.	Unclean first-aid material	5..
10.	Failure to have on hand sufficient and proper material to complete dressing	5..
11.	Lack of neatness	2..
12.	Awkward handling of patient on stretcher	5..
13.	Assistance lent by patient	5..
14.	Tourniquet improperly applied	5..
15.	Failure to stop bleeding	5..
16.	Not treating shock	5..
17.	Failure to be aseptic	10..
18.	Incorrect treatment	10..
		95
	Total discounts	....
	Percentage	....

Judge.........................

RULES GOVERNING THE ANNUAL INTER-COMPANY RED CROSS CONTESTS

1. A team will be composed of six men, one of whom acts as captain. Any employe of a mining company may be a member of a contesting team, provided he is not a physician or a nurse.

2. The captain will select one of his team to act as patient and designate the member or members of the team to work the problem.

3. The captain will control his team in their work by giving audible commands.

4. The captain may act as one of the members who will solve the problem.

5. The captain or other members of the team will not prompt the person performing the problem unless he is one of the performers. This will not apply to full-team events.

6. At the conclusion of any event, the captain will raise his right hand and announce his team number. The team will remain at its post until relieved by the judges.

7. The teams will bring their own first-aid materials, including bandages, splints, blankets, stretchers, etc., and will not be allowed to leave the patient to secure material.

8. The triangular bandages will be the standard used in the contest, but roller bandages may be used, and equal credit will be given for their proper use as with the triangular bandages.

9. All splints must be prepared on the field for each event requiring their use. Specially designed splints may be used, but they must be assembled during the time of each event requiring their use.

10. No practicing will be allowed upon the field before the beginning of the contest.

11. The teams will be numbered consecutively, beginning at No. 1, and they will occupy their consecutive positions on the field.

12. The judges will perform their work progressively, judging such number of teams in each event as the judges may determine and announce before the beginning of the contest.

13. In events involving resuscitation, the rescue of the patient and stretcher drill, the judges may require the teams to perform separately.

14. Each judge will mark the team number, event, and discount for each team, sign his name and deliver his record to the recorder of the contest.

15. The recorder will foot up the discounts and mark points made by each team in each event. The total points will be divided by the number of events and the quotient will be the average for each team for the whole contest.

16. Time will not be an element unless the team or men performing run over the allotted time or fail to give treatment properly. All events shall commence and be finished at the sounding of a gong.

Ewen Breaker Team and Their Instructors

The contest consisted of four events; and two teams, the Central, of the D., L. & W. Co., and the Lackawanna Outside, of the Temple Coal Co., each made a score of 100. To decide the winner of the cup, another problem was given, with the result that Lackawanna Outside made a score of 99 and Central 98.5; therefore the cup was awarded to the Lackawanna team, who are the fifth team to win it, no team ever having won it twice.

The members of the two teams are as follows:

Lackawanna: Harry Sax, captain, Thomas Maggs, Thomas Shultz, Reese Sax, Henry Oberts; subjects, Steve Wargo and Leon Williams.

Central: Joshua Taylor, captain, Perry Clark, Joseph Reed, Ivor Jones, Evan Davis; subject, John Simpkins.

The cup has been won as follows:

1909, Law Shaft, Avoca, Pennsylvania Coal Co.

1910, Woodward Colliery, D., L. & W. Coal Co.

1911, Brisbin Colliery, D., L. & W. Coal Co.

1912, Pine Brook Colliery, Scranton Coal Co.

1913, Old Forge Breaker, Pennsylvania Coal Co.

1914, Lackawanna Outside, Temple Coal Co.

The teams entered and the percentages they were awarded follow:

Lackawanna outside, Olyphant, Temple Coal Co., first four events, 100; tie event....... 99.0
Central, D., L. & W. Coal Co., first four events, 100, tie event 98.5
Forty Fort Coal Co., Temple Coal Co. 98.5
Harry E. Colliery, Temple Coal Co. 98.5
Pine Brook Colliery, Scranton Coal Co. 98.5
Mt. Lookout Colliery, Wyoming, Temple Coal Co...... 97.0
No. 9 Breaker, Pennsylvania Coal Co. 97.0
Bliss Colliery, D., L. & W. Coal Co. 97.0
Brisbin Colliery, D., L. & W. Coal Co. 97.0
Jermyn Coal Co., Rendham, Pa. 97.0
Sterrick Creek Coal Co....... 96.0
Coray Slope, Old Forge, Avoca, Pennsylvania Coal Co. 96.0
Ewen Outside, Pennsylvania Coal Co. (This team won the May Cup) 96.0
Storrs, No. 2, D., L. & W. Coal Co. 95.0
Mayfield, Hillside Coal and Iron Co. 95.0
Old Forge Breaker, Pennsylvania Coal Co. 95.0
Taylor, D., L. & W. Coal Co... 94.0
Dunmore, No. 2, Pennsylvania Coal Co. 94.0

Hillside Coal and Iron Co. Pennsylvania Coal Co.

The eleventh annual first-aid competition between the winning teams of the Forest City, Mayfield, Dunmore, Avoca, South Pittston, and North Pittston districts of the Hillside Coal and Iron Co. and the Pennsylvania Coal Co. was held at Valley View Park, Inkerman, Pa., September 11.

According to the data at command, Captain W. A. May, president of these two companies, was the first to take up first aid to the injured as a company proposition, and is still active in encouraging the good work, as may be realized better when it is understood that there are 90 teams at his collieries, which is equivalent to 540 men, while still others are taking lessons in the art.

Owing to this large number of teams it is customary to hold elimination contests in June, and then have a field day when the two teams having the highest mark in each of the six districts compete for the President's Cup. For the first time since these contests have been held, the company's mines were closed, to allow the employes to attend the event.

Each year has shown an increasing interest in these exercises, and visitors have increased in number; this year, however, the day being perfect, there were twice as many

spectators as ever before at these grounds. The meetings are becoming both social and society events.

The Pittston Visiting Nurses Association furnished lunch; Leek Cornet Band, of Pittston, furnished music during the exercises and for dancing in the evening. Under the direction of Dr. F. F. Arndt, of Scranton, 30 new teams had been trained sufficiently in the past year to take part in the preliminary contests, and the Ewen breaker team, of South Pittston, a new comer, annexed the cup, making in all three teams who are said to have a leg on the cup, whatever that means. They are the Law Shaft, the Fernwood, and the Ewen.

The committee in charge of the affair was composed of the District Superintendents W. R. Jennings, H. T. McMillan, F. H. Coughlan, and David Gewan.

The judges were Dr. W. G. Fulton, Dr. F. J. Bishop, Dr. B. B. Wormser, and Dr. W. A. Peck, of Scranton.

The members of the Ewen Breaker team, winners of the cup, were William Davis, captain, William Scott, Henry Skinner, Joseph Vanderberg, Tony Polis, Daniel Mallery, subject. Mark, 98. Old Forge Breaker team, which last year won the Red Cross Muckle Cup, was second with 96 points, although it was a strong favorite, and the Erie Colliery team from Mayfield, which was seventh in 1913, furnished another surprise by taking third place with 93⅓ points. The other teams to compete finished in the order following: No. 2 Shaft, Dunmore; No. 9 Breaker, North Pittston; Coray Shaft, Avoca; Forest City Breaker; No. 10 Shaft, North Pittston; Leadville Shaft, North Pittston; No. 4 Shaft, Ewen, South Pittston; Old Forge No. 1, Avoca; Old Forge No. 2, Avoca; Gypsy Grove, Dunmore; No. 5 Shaft, South Pittston; No. 1 Shaft, No. 9, North Pittston; New County, Forest City.

Those who had the best average attendance at the first-aid instruction school in each district and who won individual events in their respective districts in June, competed in one-man events for prizes worth while. The six men eligible won the following prizes:

Thomas E. Ross, North Pittston district, won the first prize, a Howard gold watch.

John O'Malley, Mayfield, won the second prize, a gold watch chain and charm.

It fitted the hand, wrist, and forearm as snugly as most manufactured splints would do, besides had a knot hole into which the thumb could be placed and the fingers clamped over the end. It is customary to encourage first-aid men to improvise and invent so as to make use of the articles nearest and best suited to aid in dressing injuries to the injured in mines.

Judges and Officials, Pennsylvania-Hillside Contest

Moses Ballentine, Avoca, won third prize, a pair of gold cuff links.

Alexander Graham, South Pittston, won a safety razor as a fourth prize.

William Gavigan, Dunmore, won fifth prize, a silk umbrella.

Delbert Burdick, Forest City, won a gold tie pin as sixth prize.

For the final test the judges in charge of events took the men singly into a canvas booth erected on the ground and gave them an oral examination.

Thomas E. Ross, who won the gold watch, was the subject of Lewis Heal, first prize winner in 1913, and who this year coached Mr. Ross.

Dr. J. B. Mahon, of Pittston, standing on the left in the picture of the winning team, former director of first-aid work for the companies, delivered the presentation speech that goes with the prizes. Doctor Mahon had in his possession an improvised splint, made by a first-aid man from the bark of a mine prop.

Lehigh Coal and Navigation Co.

The second annual outing of the employes of the Lehigh Coal and Navigation Co. was held at Lakeside, Pa., August 29. As on the year previous, first-aid events followed by land and water athletic sports comprised the program, and it was carried through with a few exceptions, although the weather conditions were bad for sports of this kind. Twenty-seven first-aid teams were the first to contend for prizes. Five of the 20 problems listed on the program were drawn from a hat and announced to the contestants, judges, timekeepers, and spectators through megaphones.

There was a one-man event, a two-man event, and three full-team events. Some idea of the efficiency of the work can be imagined, for the lowest was 88⅘ per cent., and 12 of the teams were above 95 per cent.

The first prize of \$25 in gold and individual silver medals was won by the Nesquehoning Outside team

with an average of 100 per cent. The team was composed of William J. Adams, captain, Oscar Strohl, Clarence McGorry, William Strohl, and Samuel Azer.

The Electrical Department team also made 100 per cent., but in the extra event to decide the better team, was forced to be content with the second prize, $15 in gold. The team was composed of Harold Ramsay, captain, Thomas Whidin, George Israel, Harry Wheinmeyer, and Warren Holmes.

The third prize of $10 in gold was won by the Lansford Slope team with 99⅕ per cent. This team was made up of D. J. Jones, captain, George Boyle, David Morgans, James Cunningham, and Edward Mimmick.

Three minutes were allowed for each solution in the one-man and two-man events, and 10 minutes for the full-team problems.

The judges were Doctors E. H. Kistler, W. H. Kasten, M. H. Newmiller, W. F. Ely, W. C. Scott, and Robert Kistler, of Lansford; J. E. Beale, of Coaldale; W. H. Hinkle, of Tamaqua; J. H. Behler, of Nesquehoning; and B. A. Erwin, of Mauch Chunk.

Teams from the following collieries competed:

1. Nesquehoning Outside, W. J. Adams, captain.
2. Nesquehoning Tunnel No. 1, C. Keeney, captain.
3. Nesquehoning Tunnel No. 2, P. Boner, captain.
4. Nesquehoning Shaft No. 1, F. Heffler, captain.
5. Nesquehoning Shaft No. 2, J. Lewis, captain.
6. Nesquehoning Summit, J. Forrest, captain.
7. Lansford Outside, A. Gibson, captain.
8. Lansford No. 4 Slope, Harry McElmoyle, captain.
9. Lansford No. 4 Shaft, A. McMullen, captain.
10. Lansford No. 5 Shaft, S. Hollenbach, captain.
11. Lansford No. 6 Shaft, B. Cunning, captain.
12. Coaldale Outside, W. Callahan, captain.
13. Coaldale No. 8 Shaft, J. Boyle, captain.
14. Coaldale No. 8 Slope, T. J. Evans, captain.
15. Coaldale No. 9 Shaft, D. Moser, captain.
16. Coaldale, Springdale, T. Whildin, captain.
17. Greenwood Outside, R. Werner, captain.
18. Greenwood Inside, William Sweeney, captain.
19. Rahn Shaft, James Filer, captain.
20. Fosters Tunnel, T. Thomas, captain.
21. Lansford Shops, D. Jones, captain.
22. Tamaqua Outside, C. Gould, captain.
23. Tamaqua Inside, No. 1, O. Bell, captain.
24. Tamaqua Inside, No. 2, C. Erbe, captain.
25. Hauto Washery, E. Mulhearn, captain.
26. Coaldale Washery, C. George, captain.
27. Electrical Department, H. Ramsay, captain.

Immediately following the regular first-aid contest there was a demonstration of new devices in connection with first-aid work.

Special Stretcher Used by Lehigh Coal and Navigation Co. Teams

Prize $10 in gold was offered to the team demonstrating the most practical device. A demonstration of the new mine stretcher shown herewith followed, this particular stretcher being adapted to pitching places. At the left is shown the stretcher set for a dislocation of the right hip, and at the right is seen the position of the injured limb, while the other limb is firm against the foot-rest.

Following the first-aid contest came the field and water sports interspersed by the dinner at 1 o'clock. The five districts compete in the sports for the possession of the large silver cup annually contested for until won by any one district three times. No member of a baseball team was allowed to compete and the winning positions counted 5, 3, and 1 in points except the water event No. 3, "Chasing the Duck," in which the winner was awarded two points, and field event No. 8, "Tug of War," in which the winner was awarded eight points.

The Lehigh Coal and Navigation

Co.'s men may have family quarrels, but when the question of loyalty is involved they all pull together for their company. This feature demonstrates better than words that good-will and comradeship prevail, a condition which any sensible man will admire, because a man does not stay in a place for wages alone; in fact, congeniality has much to do with contentment.

Lehigh Valley Coal Co. Contest

The Lehigh Valley Coal Co. has a total of 537 men comprising 92 teams engaged in first-aid work; and of these, 78 teams were entered in the preliminary contests held in each division in the early part of August. As the result of these contests the winning teams in each division were chosen to take part in the annual first-aid meet held August 29, at Hazle Park, near Hazleton.

The teams entered were, Westmoreland, of the Lackawanna Division; Derringer, of Coxe Bros. Branch; Franklin, of Wyoming Division; Primrose, of Delano Division; and Centralia, of Mahanoy and Shamokin Division. On account of unfavorable weather, the contest was held on the stage of the theater at the park, and while the space for the teams was somewhat limited, the audience could see well, and the contestants were not hindered in their work by spectators crowding about, as often happens in the open field.

The first-aid work of this company is under the direct management of M. W. Price, working under the supervision of John Lloyd, efficiency engineer of the company. After an address of welcome by Mr. Lloyd, Charles F. Johnson, superintendent of the Luzerne County Industrial School for Boys, made a short address on the philanthropic feature of first-aid work.

Judges at Lehigh Valley Coal Co. Contest

The judges were Dr. Walter Lathrope, superintendent of the State Hospital at Hazleton; Dr. L. M. Thompson, Wilkes-Barre; and Miss A. M. Anderton, in charge of Social Service work of Wilkes-Barre Hospital, perhaps the first woman judge at a first-aid contest. The program, which consisted of three full-team events and a one-man contest, was announced by Mr. John Lloyd. The excellence of the work done by the different teams was such that the utmost care was necessary on the part of the judges to discriminate rightly in the quality of work done, and in the final reckoning the Westmoreland, Franklin, and Derringer teams tied for the first place, with a score of 99, and the award was given to Westmoreland on account of a slight advantage in time.

Westmoreland Team, Lehigh Valley Coal Co.

The names of the men on the Westmoreland team are: James Morris, captain, Joseph Johnson, Frank Lutz, Albert Larmuth, and Ernest Space.

The percentages were as follows: Westmoreland, 99, time, 27 minutes 45 seconds; Derringer, 99, time, 29 minutes 16 seconds; Franklin, 99, time, 34 minutes 5 seconds; Primrose, 98⅔, time, 28 minutes 10 seconds; Centralia, 97, time, 33 minutes 22 seconds.

In the one-man contest the marking was as follows: Simon Fellin, Derringer, 99.5; Anthony Gluding, Primrose, 99.25; John O'Neill, Franklin, 99; James Morris, Westmoreland, 99; John Wilson, Centralia, 97.5.

The cup awarded to the winning team, the Westmoreland, was won in 1913 by Derringer and in 1912 by Packer No. 5. It was announced that the winning team and the cap-

tains of all five of the teams would be sent to New York by the company to take part in the exhibition of the American Mine Safety Association on September 7 to 10.

At noon, a well-appreciated lunch was served in the dancing pavilion to all present.

Vice-President and General Manager F. M. Chase is greatly interested in the first-aid work of the company and personally assisted in the conduct of the meet. In a few remarks before awarding the prize to the winning team, he stated that in the last year ending June 30, 1914, there had been 53 lives lost in their mines, which was 23 less than the year previous, and that in the first 6 months of the current calendar year there had been 25 lives lost, as against 40 in the same period of last year; and that much of the saving could be attributed not merely to the efficacy of first-aid work but to the increased carefulness induced by the study of the subject.

The meeting was largely attended by men prominent in the mining business of the region. Among these were A. B. Jessup; General C. Bow Dougherty; Mine Inspectors A. B. Lamb and S. J. Jennings; Dr. J. Michaelis, of New York; J. M. Humphrey, mining engineer; Thomas Thomas, mining superintendent, of the Lehigh Valley Coal Co., and many others.

Scott Colliery Outside Team

Susquehanna First-Aid Meet

The first-aid movement in the coal fields of the United States was started in Schuylkill County, Pa., by a Philistine, that is, a person deficient in culture, a prosaic practical man whose chief aim in life (it seemed at that time) was to heap contumely on anthracite operators in public and engender discord among mine workers in private. In other words, he was a labor agitator. Of course, the man had no conception of his little acorn growing into a sturdy oak whose branches would cover the United States, yet he planted it and the operators he so maligned found the little tree, nurtured it, and are now happy to spend time and money to increase its growth. The history of this man's humanity to man, so far as the first-aid movement can be traced, is found in the history of Schuylkill County.

Before the passage of the Ambulance Act in May, 1881, injured mine workers suffered greatly before they could be gotten from their working places to their homes where proper medical attention and nursing could be given them. On one occasion that progressive miner who was termed a Philistine, accompanied by his partner entered his breast early in the morning where gas had accumulated in a hole in the roof. This was ignited and his "butty" was badly burned. After his removal to the surface, he was still 4 miles from home and the Philistine asked the outside boss if he could do anything toward helping the man home. The boss willing to do all he could replied that the two-wheeled ash cart, the only convenience at hand, could be taken. The injured miner was placed in the shade of a neighboring tree, oil poured on his burned body and blasting paper used to cover the burns, as that was the best substitute available for picric acid gauze, waxed paper, cotton, and linen bandages now found in first-aid kits. Before the ash cart could be brought into use, dinner time arrived and then followed the jolting ride over rough roads that caused excruciating pain.

In another accident, just about that time, a miner had a leg broken and in the absence of any other conveyance was tied to the back of a mule and thus carried home. This and similar occurrences caused the Philistine to think that ambulances should be kept in readiness at all mines for the purpose of conveying the injured to their homes. The miner commenced to agitate for this reform, and the Ambulance Act was passed, requiring the anthracite mines to have ambulances. G. M. Williams, a mine inspector in Luzerne County at that time, stated in his report for 1882 that the operators generally observed the Ambulance Law of 1881, and the writer remembers how the office force of Coxe Brothers & Co. examined the first ambulance to arrive in Drifton.

Since that time, operators have improved these ambulances, have added city ideas to their own inventions, and adapted them to conditions about mining towns so that in most instances ambulances are better constructed and equipped than the law demands. The remarkable changes which have been made since 1881 in caring for the injured at anthracite mines have been due to the operators encouraging their men to avoid accidents through careless-

ness, but finding this plan not altogether satisfactory they encouraged the mine inspectors to frame a law that would make mine foremen a sort of first-aid corps, and finally they encouraged the mine workers to take up first-aid work. This historical introduction brings the reader to an understanding of why the fifth annual inter-company ville. Those from Minersville took special trolley cars to Pottsville. Among the first to arrive at the Wilkes-Barre station was Mr. Edgar, who not seeing the train was heard to remark that it was the resurrection morn and he was the first up. This mistake was natural enough, for he was not aware that R. D. N. Hall, editor, and C. L. Fay, aided in impressing the miners and visitors that these companies were doing nobly their part to decrease accidents, and the results compared with the accidents before the plan was inaugurated show that the men are doing their part as well. One of the mottoes was "Who suffers most when an accident happens? You or the company?"

The Susquehanna Coal Co. First-Aid Meet

contest of the Susquehanna-Lytle Coal Companies took place at Edgewood Park, Shamokin, September 26.

These two companies are in charge of Morris Williams, president, and Robert A. Quin, manager. The collieries of these companies being widely separated, are for convenience classified in divisions known as the Wyoming Division, Luzerne County; Shamokin Division, Northumberland County; William Penn colliery, Shenandoah, Schuylkill County; Lykens Division which is in Dauphin County, and Lytle Coal Co. of Minersville, Schuylkill County.

To assemble the forty-four teams that took part in this contest required three special trains, which left in the early morning from Wilkes-Barre, Lykens, and Pottsville. Those from Minersville took special trolley cars to Pottsville. Among the first to arrive at the Wilkes-Barre station was Mr. Edgar, who not seeing the train was heard to remark that it was the resurrection morn and he was the first up. This mistake was natural enough, for he was not aware that R. D. N. Hall, editor, and C. L. Fay, treasurer of the Coal Mining Institute of America, had earlier camped in the private car that was to carry the invited guests from Wilkes-Barre and at the time stood in the yard. The train started promptly on time and those guests who had not been able to get breakfast were fed on the car. On reaching Shamokin, trolley cars were standing ready to convey the excursionists to the park.

On entering the park, there was an exhibit of the Safety Department inaugurated one year ago to advance the "safety-first" movement. In this exhibit were signs used to warn of dangers, and illustrations to show what had happened because men had neglected to avoid the dangers specified. Safety lamps, electric lamps, pulmotors, helmet apparatus, and "Don't" mottoes aided in impressing the miners and visitors that these companies were doing nobly their part to decrease accidents, and the results compared with the accidents before the plan was inaugurated show that the men are doing their part as well. One of the mottoes was "Who suffers most when an accident happens? You or the company?"

In a short time after reaching the park, the forty-four teams were in position to commence the contest. The grounds were arranged with four rows of white brattice cloth stretched in front of the grandstand so others could witness the work besides those who were crowded four deep about the rope enclosing the teams. Dr. J. H. Hughes and Superintendent Francis H. Kohlbraker, of the Wyoming Division, entered four teams from Colliery No. 5, three teams from No. 7, both at Nanticoke, and five teams from Colliery No. 6 at Glen Lyon. Dr. J. M. Maurer and Superintendent E. A. Van Horn, entered two teams from William Penn Colliery, Shenandoah, and Superintendent W. R. Remhardt two from Hickory Ridge, two from Hickory Swamp, four from Luke Fiddler, two from Scott,

five from Cameron at Shamokin, also four from Richards colliery, three from Pennsylvania colliery, Mt. Carmel, one being a breaker boys' team. Dr. G. M. Stites and Superintendent William Auman, of the Lykens Division, brought three teams from Lykens and three from Williamstown. Dr. B. C. Guldin and Superintendent D. V. Randall, of the Lytle Coal Co., brought two from Minersville. These forty-four teams worked four problems, the first row starting to work at the command of Doctor Maurer, and as soon as they were well under way he started the second row and so on. This arrangement gave the judges, Dr. J. B. Rodgers, of Pottsville, Dr. D. H. Lake, of Kingston, and Dr. J. W. Geist, of Wilkes-Barre, an opportunity to watch the work as it progressed and to judge its completion. These surgeons have served 3 years at this contest, have been teachers in this work for other coal companies, and are efficient in finding defects without consultation. Each surgeon marks his own demerits and the clerks average the marks so that no one knows who receives the highest mark until the announcement is made by the secretary.

The French Bronze medals awarded as first prizes in the One-Man event went to Andrew Saduskie, of the Pennsylvania No. 1 No. 5 Slope team. The Red Ribbon badge as second prize to William Stevens, of Glen Lyon, No. 6 Tunnel team.

The French Bronze medals awarded for the Two-Man event went to Andrew Saduskie and Ralph Kendter, Pennsylvania No. 1 No. 5 Slope team, and second prizes to Robert Monday and John Schrama, Nanticoke No. 4 Slope team.

The French Bronze medals awarded in the Three-Man event went to Ernest Bleith, John Wadzinski, and David Edwards, Nanticoke No. 2 shaft team, and second prizes to D. P. Burke, Jacob Hollister, and Ralph Bickel, of the Richards Outside team from Mt. Carmel.

In these contests, the subjects are considered members of the teams and, therefore, received prizes. In the Full-Team event, which was for the silver cup and gold-plated medals, the surgeon who has taught the winning team receives a silver medal in honor of the occasion. In 1913, Scott Colliery Outside team composed of William Horne, captain, George Lessig, Michael Rafferty, George Morse, Andrew Parker, Harper Stroup, subject, and Dr. G. M. Stites, won the cup and medals. This year, Williamstown No. 1 team won the cup and the medals. From the register, this team is made up as follows: Joseph Llewellyn, captain, James Byerly, William Smith, H. Troutman, John Gittings, and Felix Samuels, subject. The second place went to Richards Colliery Outside team consisting of D. P. Burke, captain, Jacob Hollister, Charles Dietz, Ralph Bickel, Harold Brokenshire, and Charles Williams, subject.

The problem for the Cup event was to dress a man with a broken jaw, fracture of the left collar bone, compound fracture of the right arm and fracture of the pelvis. The teams went at the work with a snap that showed determination to win. When one team would complete the problem, the subject was carried on a stretcher around the field so all could see the work.

When they were in front of the grandstand, the breaker boys' team stopped and up-ended their stretcher to show that the broken-backed person was securely fastened to the splint so that he could be handled at any angle. Other teams at times followed suit. When forty-four stretchers pass in review, one at a time, while the excellently balanced Shamokin band softly plays "Abide With Me," exercises of this kind reach the climax in acting and were they in a theater would bring tears as did the acting and this same hymn when sung in the death scene of "Hazel Kirk." Here, however, they brought applause for good work even though the audience was serious.

At the conclusion all first-aid men, between 800 and 900, formed in four divisions and with the superintendents and doctors from each division paraded around the ground and stopped before the grandstand, in front of which a speakers' platform had been erected. Mr. Quin, with love beams sparkling from his countenance, complimented the men on the efficiency they displayed in handling the problems and the improvement which the work showed over the previous year. He characterized it as a noble work which is being fostered by all industries of this country, but stated that nowhere had it attained such perfection as in the anthracite region of Pennsylvania. He thanked them for the interest they had taken in studying first-aid work in order to alleviate the injuries that might happen to their fellow men and possibly save lives. He thanked them for their loyalty to the management and the company whom they represented. He referred to the large audience of men and women in the grandstand who had come from distant parts of the state and who had left their vocations to show their admiration for the men who through kindness of heart were willing to devote time to the study and practice of first-aid to the injured. He hoped they would continue the good work and that others would take it up and thus demonstrate that they were trying to save life while the soldiers of Europe were trying to destroy life. After telling of the additional dangers due to deeper mining in late years, he stated that the company is spending $50,000 a year on special safety inspectors, or as he termed them, a "first-aid corps to the uninjured." This new corps is in addition to the established safety devices and regular inspections of the company which have reduced the loss of life considerably over past years. The great throng of upturned faces showed marked attention to Mr. Quin's remarks, and that they were appreciated was evident from the applause he received from time to time.

President Morris Williams followed Mr. Quin and compared the time when they carried injured miners from the mines on doors and planks with the present conveniences for making the injured comfortable below ground before removal to the surface. He stated that the industry which does not take care of its men is not fit to exist, and he expressed the hope that a just compensation law would soon become a reality in this state. "The happiest day in my life," he exclaimed, "will be when the mine workers get what is coming to them." Mr. Williams was on the commission which drew up a compensation bill for the last legislature, and has been reappointed. At one time it looked as if the bill would be enacted, but politics and greed intervened, and all the work and time expended was useless. President Williams was followed by President Richards, of the Philadelphia & Reading Coal and Iron Co., who, in a few appropriate words, presented the cup to the winning team. About this time, Mr. Quin remembered to congratulate the Pennsylvania colliery breaker boys' team, who, dressed in white suits, white stockings, and sneakers, competed on equal terms with the men. The eight nurses from the Shamokin Hospital, who were guests of the company, were good judges of this kind of work and appeared to take just a little more interest in the breaker boys than the others. There are two animals, the wolf and hyena that attack their injured and these were brought to mind when we heard disappointed rooters from one colliery criticising its team (who were undoubtedly disappointed more at losing the cup than the rooters who had not worked a year practicing) and among the things said were "you did not do as well as the breaker boys." That remark, although intended for sarcasm, probably hurt at the time; however, there were thirty-nine teams in the contest behind the breaker boys.

It is suggested for the benefit of those who may need the services of their first-aid corps at any time that one word of encouragement is worth 100 knocks to disappointed men. Try it. The day was one of enjoyment to all present, and the fifth annual inter-company contest will be recorded as the most successful held up to this time. However, we cannot prophesy that it will eclipse future events, for Mr. Gloman thinks up new schemes and with the able assistance of the superintendents, doctors, and others, furnishes new attractions each year.

Early Underground Hospital at Shamokin

At lunch time, the teams and guests were marshaled by Gen. C. Bow Dougherty and marched in fours to the lunch served in the grove. After the excellent lunch, the exercises were renewed and at the conclusion the spectators and teams were satisfied with the day's outing. The judges stated that there was considerable improvement, both in the neatness and technique of the work over the previous year. The broken back splint described by Mr. Bert Lloyd, of Trinidad, Colo., in the August, 1913, issue of The Colliery Engineer was made and used in this contest by one team, and Doctor Lake considers that it is good.

Keystone Coal and Coke Co. First-Aid Meet

The third annual contest between teams from the collieries of the Keystone Coal and Coke Co. was held at Athletic Park, Greensburg, Pa., September 5. Prior to the exercises the 21 teams paraded through the principal streets of the business sections of the town, keeping step to the music of the Madison and New Alexandria bands, whose members are also employes of the company. The trophy cup, presented by Vice-President L. B. Huff, has to be won thrice before it becomes the permanent property of any team. So far the Crows Nest team and the Arona "A" team have been winners, and if the latter team is able to retain it next year, it will belong to them. In addition to the cup, $60 in cash went to the winning team whose members were: L. L. Garlow, captain, James McMahon, Robert McMahon, Light Seabury, Hugh Leonard, and William Richard, subject.

Before the contests, the team captains drew numbers, the odd-numbered teams worked together at one period and the even-numbered teams at another period, all on the same problem. Six problems were demonstrated, and the work of the teams was so close that fine points decided the contest; as it was, the judges were compelled to declare a draw between the four teams from Greensburg No. 2, Hempfield No. 1, Salem A, and Sewickley for second place. To complicate matters further, Arona Outside, Greensburg No. 1, and Greensburg No. 3, tied for the $20 third prize, and finally the judges, not being content, tied Greensburg No. 4, Crows Nest, and Huron for the fourth prize of $10.

The judges were the experienced National Guardsmen, Major Louis P. McCormick, Tenth Regiment; Major William Judd Crookston, Fourteenth Regiment; Captain Edward M. Iland, Eighteenth Regiment; Captain Robert S. McKee, Tenth Regiment; and Lieutenant Frederick B. Shaffer, Tenth Regiment. As we figure it, these ties cost the company $180 additional prize money; however, the officers were satisfied, in fact H. F. Bovard, general superintendent, said: "Due to the fact that such an elegant showing was made throughout the contest, it was deemed advisable to award the full cash prize to each team rather than have the ties worked off."

The illustration of the winning team also shows the second team

Keystone Coal and Coke Co.
Third Annual First-Aid Contest, Greensburg, Pa., September 5, 1914

Teams Contesting	Order on Program	Per Cent. Attained	Rank	First Event Time Min.	First Event Discount	First Event Cause For Discount	Second Event Time Min.	Second Event Discount	Second Event Cause For Discount	Third Event Time Min.	Third Event Discount	Third Event Cause For Discount	Fourth Event Time Min.	Fourth Event Discount	Fourth Event Cause For Discount	Fifth Event Time Min.	Fifth Event Discount	Fifth Event Cause For Discount
Arona Team "A"........	6	100.0	1	10			5			10			7			12		
Greensburg No. 2.........	5	99.6	2	12			5			12	2	Not doing most important thing first	10			12		
Hemfield No. 1.	10	99.6	2	13			4	2	Wrong artificial respiration	12			10			11		
Salem Team "A"........	14	99.6	2	11	2	Not doing most important thing first	4			10			10			12		
Sewickley Outside..........	17	99.6	2	10			5			7			8			13	2	Awkward handling of patient on stretcher
Arona Outside..	1	99.4	3	14			6			14			8	1	Not stopping bleeding	14	2	Awkward handling of patient on stretcher
Greensburg No. 3.........	7	99.4	3	11			5			10			9			10	3	Loose splints. Captain's failure to command properly
Greensburg No. 1.........	21	99.4	3	10	2	Not stopping bleeding properly	4			11			8	1	Awkward handling on stretcher	10		
Greensburg No. 4.........	3	99.2	4	11	2	Not doing most important thing first	5			11			9	2	Not caring for shock. Captain's failure to command properly	11		
Crow's Nest....	15	99.2	4	11	2	Not doing most important thing first	6			10			11	2	Slowness in work	12		
Huron.........	20	99.2	4	9			5			11	2	Loose bandage	9			11	2	Loose splint
Keystone shaft outside.......	13	99.0	5	11			6	2	Not stopping bleeding	8	1	Lack of neatness	9	2	Awkward handling on stretcher	14		
Salem team "B"	19	99.0	5	11			4	2	Wrong artificial respiration	11	2	Captain's failure to command properly	7	1	Lack of neatness	13		
Carbon team "B".........	16	97.8	6	13			5			8	2	Failure to entirely cover wound	10	4	Loose bandage	12		
Sewickley team "A".........	4	98.6	7	11	2	Awkward handling on stretcher	6	2	Not doing most important thing first	11	2	Failure to be aseptic	7	1	Failure to be aseptic	12		
Madison.......	8	98.6	7	9			3			7			6	6	Loose bandage in wrong place. Rough handling of fractured leg	13	1	Not taking care of shock
Carbon team "A".........	11	98.6	7	10	3	Not taking care of shock	3			5			12	4	Slowness in work. Failure to cover wound	12		
Keystone shaft "A".........	12	98.6	7	12	1	Failure to entirely cover wound	4	4	Wrong artificial respiration	9			8	2	Failure to entirely cover wound	14		
Sewickley team "B".........	18	98.6	7	12			4			10	5	Failure to be aseptic	9			13	2	Awkward handling on stretcher
Keystone shaft inside........	2	98.0	8	12	2	Not doing most important thing first	4			8	2	Failure to be aseptic	6	1	Awkward handling on stretcher	14	5	Not taking care of shock
Claridge........	9	97.6	9	13	3	Loose bandage. Not covering wound. Awkward handling on stretcher	6	5	Wrong artificial respiration	9	2	Awkward handling on stretcher	7	2	Failure to entirely cover wound	15		
Average..		99.0		11.2			4.7			9.8			8.6			12.4		

from the same mine, and in the foreground from left to right, Superintendent D. Fleming, Assistant Superintendent Charles Daily, and Mine Foreman George Wagner.

The accompanying chart is a reproduction of the tally sheet used by the scorers at this contest, and is published because it can be used to advantage at other companies' exercises; besides, all those engaged in first-aid work can study and follow it as a guide for the benefit of those operators and men who enter teams in the Bureau of Mines, American Mine Safety Association, or Red Cross, first-aid meetings.

In addition to the first-aid exercises there was a smoke-chamber demonstration to show the use of modern mine-rescue apparatus. It was performed by William Nisbet, chief inspector, Keystone Coal and Coke Co., Ralph Harrison, mine foreman, Sewickley mine; Jacob Kirtz, mine foreman, Crows Nest mine; Martin Shopsky, mine foreman, Keystone shaft.

American Mine Safety Association

The American Mine Safety Association held its third annual business meeting in New York City, September 7, 8, and 9. There was no business of importance transacted owing to the small attendance, the feature being the demonstration of first-aid and rescue work by the Lehigh Valley Coal Co.'s prize winning teams.

The rescue squad after recovering the man found unconscious in "bad air," turned him over to the first-aid team from the Westmoreland colliery, the winners of the first prize, and the loving cup at the company's meet on August 29. After reviving the patient with the pulmotor, the team treated him for simple fracture of the left thigh, crushed right foot, and simple fracture of the skull. The work was highly praised by J. P. Reese, president of the Association and general superintendent of the Chicago & Northwestern Railway coal properties.

H. M. Wilson, secretary of the Association, gave some interesting facts in his report for the past year. The membership has increased to 549, almost doubling its number. At present he stated that 31 states, as well as the District of Columbia, Mexico, British Columbia, Alberta, and Alaska, were represented in the Association, as compared with 21 states last year.

give a medal or certificate to the patient or subject of a first-aid team. Finally it was decided that he was entitled to a reward as well as the rest of the team.

A recommendation of the executive committee was that a "booster" be employed by the Association to increase the membership, he to be paid by a percentage of dues received.

Arona Outside and Inside Teams, Keystone Coal and Coke Co.

The Association has donated 101 medals of gold, silver, and bronze during the past year at field meets held at Springfield, Gillespie, and Harrisburg, Ill.; Lexington, Ky.; Bluefield, W. Va.; Pittsburg, Kans.; Seattle, Wash.; Somerset, Pa.; Ishpeming, Mich.; Reno, Nev.; and Jackson, Calif.

After adjourning, the Lehigh Valley men were taken to Coney Island by steamer at the expense of the Association. Meeting again at Terre Haute, Ind., on the evening of September 11, more business was transacted with a large attendance. Dr. A. F. Knoefel, chairman of the first-aid committee, reported that his committee had decided the Schaefer method of respiration preferable to the Sylvester. This was adopted, and an equitable arrangement of penalties was drawn up to take the place of the present one.

There was considerable discussion as to whether the Association would

A measure was passed, authorizing the executive committee to award Association medals at contests where the Association is represented by a local man, or where the city holding the contests bears the expense of having an Association member present. This was done to insure a member of the Association being present at all meets where their medals are awarded.

John C. Davidson, of Paxton, Ind., was voted the first medal awarded by the Association for heroism. He risked his life to save others at Starkville, Colo., August 10, 1910, and again at Dawson, N. Mex.

The nominating committee then reported and announced their selection of officers for the coming year: President, Dr. August F. Knoefel, Indiana; First Vice-President, Joseph Fletcher, Kansas; Second Vice-President, F. W. Sperr, Michigan;

Third Vice-President, William Green, Ohio. President John P. Reese cast the ballot electing the new officers.

W. H. Aldridge, New York, was reelected a member of the executive committee and Dr. Ralph F. McHenry, of Pennsylvania, and Albert Birch, of Nevada, were elected as new members.

First Aid at Terre Haute Meet

A vote of thanks was extended to the local committee and to the Indiana Coal Operators' Association for its offer to defray the expenses of the meet in Terre Haute.

The next day, Saturday, September 12, the field events took place, the first-aid work in the forenoon, accompanied by an explosion of coal dust from seam No. 4 of the Vandalia No. 10 mine at Dugger, Ind., in the steel tube shipped from Pittsburg, Pa.

The first test, with the permissible explosive, failed to cause an explosion by the coal dust present. The second test, with a charge of 3F black powder of equal strength as the "permissible," exploded the dust with great violence.

In the first-aid contest, 29 teams from 19 companies competed. Two teams were from Pennsylvania, the rest from Indiana and Illinois.

Six events were demonstrated, the resulting percentages showing 14 ties which were worked off by additional simple problems.

Eight teams representing six companies took part in the mine-rescue contest. A long frame shed, partly enclosed, acted as a mine; it represented the roadway, and had obstructions in it to test the teams in carrying their injured men over such traveling ways.

In the evening a smoker was held at the Terre Haute House. Retiring President J. P. Reese; William Houston, of the United Mine Workers; Edgar A. Perkins, Chief Mine Inspector for Indiana; and Carl Scholz, president of the American Mining Congress, made brief addresses.

Doctor Knoefel, the new president, then took the stand and awarded the following prizes:

FIRST-AID PRIZES

Special Grand Resuscitation Prize. A silver cup known as the "Westphalia Cup" donated by S. F. Hayward, the American agents for the Westphalia mine-rescue and oxygen reviving apparatus. This cup is presented to the team excelling in the methods of resuscitation and will remain in possession of the team winning it until the date of the next annual meet, when it will be contested for again. It becomes the property of the team winning it at any two consecutive meets.

This prize was won in 1913 by the team representing the Penn-Mary Coal Co., Heilwood, Pa., and again this year by the same team.

The prizes for the team scoring the highest general average were as follows:

Grand Special Gold Prize. One hundred dollars in gold, donated by Indiana Coal Operators' Reciprocal Organization, Terre Haute, Ind., to the team showing the greatest efficiency in all lines in the first-aid events.

The Colliery Engineer Challenge Cup. A silver cup known as "The Colliery Engineer Cup" donated by The Colliery Engineer to remain the property of the team winning it until the next annual meet, when it will be contested for again. The team winning this cup at two consecutive meets will become the sole owner of it. This cup to go to the team scoring the highest number of points in all five events of the contest. It was won last year by the team representing the Penn-Mary Coal Co., Heilwood, Pa. This year the winner was the team from the Bunsen Coal Co., Westville, Ill., John Krainock, captain, C. E. Newman, J. DeBarber, Stephen Shaffer, Charles Elliott, and Stull Boots.

In addition to the above there were six American Red Cross bronze medals and six American Mine Safety Association silver medals making one of each for every member of the highest team.

Second prize: American Mine Safety Association bronze medals, American Red Cross certificates, and Burroughs-Welcome tabloid first-aid case. Won by Penn-Mary team, Heilwood, Pa.

Third prize: Medals donated by Indiana Coal Operators; American Red Cross certificates. Won by Oak Hill team of J. K. Dering Coal Co., Clinton, Ind.

Fourth prize: Medals donated by the Indiana Coal Operators. Won by No. 9 mine team, Vandalia Coal Co., Linton, Ind.

Fifth prize: Medals donated by the Indiana Coal Operators. Won by Crown Hill team of Clinton Coal Co., of Clinton, Ind.

Sixth prize: Medals donated by the Indiana Coal Operators. Won by Superior Coal Co. team, No. 2 mine, Gillespie, Ill.

Seventh prize: Medals donated by the Indiana Coal Operators. Won by No. 1 mine team, Superior Coal Co., Gillespie, Ill.

Eighth prize: Medals donated by the Indiana Coal Operators. Won by Calora Coal Co. team, Jasonville, Ind.

Ninth prize: Medals donated by the Indiana Coal Operators. Won by No. 3 mine team, Superior Coal Co., Gillespie, Ill.

Tenth prize: Medals donated by the Indiana Coal Operators. Won by No. 82 mine team, Vandalia Coal Co., Terre Haute, Ind.

Eleventh prize: Medals donated by the Indiana Coal Operators. Won by Cambria Steel Co. team, Johnstown, Pa.

Twelfth prize: Medals donated by the Indiana Coal Operators. Won by Universal team, Bunsen Coal Co., Universal, Ind.

Thirteenth prize: Medals donated by Indiana Coal Operators. Won by No. 1 team, J. Wooley Coal Co.

Fourteenth prize: One Hirsch electric safety lamp. Won by No. 10 mine team, Vandalia Coal Co., Dugger, Ind.

Fifteenth prize: One Wico electric safety lamp. Won by O'Gara Coal Co. team, Harrisburg, Ill.

Sixteenth prize: One electric coffee percolator. Won by Monon Coal Co. team, Cass, Ind.

Seventeenth prize: One Johnson first-aid cabinet. Won by No. 20 mine team, Vandalia Coal Co., Linton, Ind.

Eighteenth prize: One carafe. Won by team representing the Indian Creek Coal and Mining Co., Bicknell, Ind.

Nineteenth prize: Six bottles Lilly's liquid soap. Won by Sugar Valley Coal Co. team, West Terre Haute, Ind.

Twentieth prize: Six bottles Lilly's liquid soap. Won by team of Knox Coal and Mining Co., Bicknell, Ind.

Special Prizes

For team displaying most proficiency in improvising materials and dressing, six Baldwin lamps. Won by Calora Coal Co. team, Jasonville, Ind.

The Colliery Engineer Challenge Cup

For the team scoring highest number of points in one-man event, one Westinghouse electric fan and two bicycle tires. Won by O'Gara Coal Co. team, Harrisburg, Ill.

For team scoring highest number of points in two-man event, one subscription to *Coal Age*, *Safety Engineering*, and *Black Diamond*. Won by Penn-Mary team, Heilwood, Pa.

Broken Back Bandaged With 3 Picks—Penn-Mary Team

Mine-Rescue Prizes

First prize: The Colliery Engineer Challenge Cup. A silver cup known as "The Colliery Engineer Cup" donated by The Colliery Engineer. This cup to go to the team scoring the highest number of points in all events and to remain in possession of the team winning it until the date of the next annual meet, when it will be contested for again. The team winning this cup at two consecutive meets will become the owner of it. This cup was won in 1913 by the team representing the Pittsburg Coal Co. The winner this year was the Oak Hill team, J. K. Dering Coal Co., Clinton, Ind., Scott Amour, captain, Matthew Kerr, George Waters, Stanley Howell, George Wilson.

To the above winners of the first prize were also awarded five Baldwin hand lamps, and six American Mine Safety Association medals.

Second prize: Medals donated by a number of the Indiana coal operators, five Justrite lamps, one Justrite lantern. Won by Paxton No. 1 team, J. Wooley Coal Co., Paxton, Ind.

Third prize: Five subscriptions to *Coal Age*. Won by Paxton No. 2, J. Wooley Coal Co., Paxton, Ind.

Fourth prize: Five subscriptions to *Black Diamond*. Won by Superior Coal Co., Gillespie, Ill.

Fifth prize: Koehler Aluminum Safety Lamp. Won by Bunsen Coal Co., Universal, Ind.

Sixth prize: Wolf safety lamp. Won by Mine No. 82 team, Vandalia Coal Co., Terre Haute, Ind.

Dr. R. F. McHenry, surgeon of the Penn-May Coal Co. at Heilwood, Pa., whose team won the Resuscitation cup again, caused a sensation by declaring that he was opposed to the giving of prizes of any sort.

A novel feature of the meet was the award of a prize to the team displaying the most proficiency in improvising material and dressings. This, after all, is the prime requisite in the work—making use of material at hand.

It is interesting to know that first-aid work in the Terre Haute section

was inaugurated by John Sutton in February, 1911. Mr. Sutton was then a fire boss for the National Coal Co. The Coal Bluff Mining Co. then took up the work, and during the latter part of the same year the Operators' Association took interest.

Lehigh and Wilkes-Barre Field Day

The Lehigh and Wilkes-Barre Coal Co. held its fifth annual field day on August 31, at Sans Souci Park, near Nanticoke, Pa. The first-aid teams were all dressed alike in uniforms of kaki, with white sneakers and white neckties, a feature which added neatness and, like nurses' uniforms, effective tone to the occasion. Charles F. Huber, vice-president of the company, was present and, assuming from the manner in which he critically examined the dressing, it is probable that he could qualify as a judge in case of necessity.

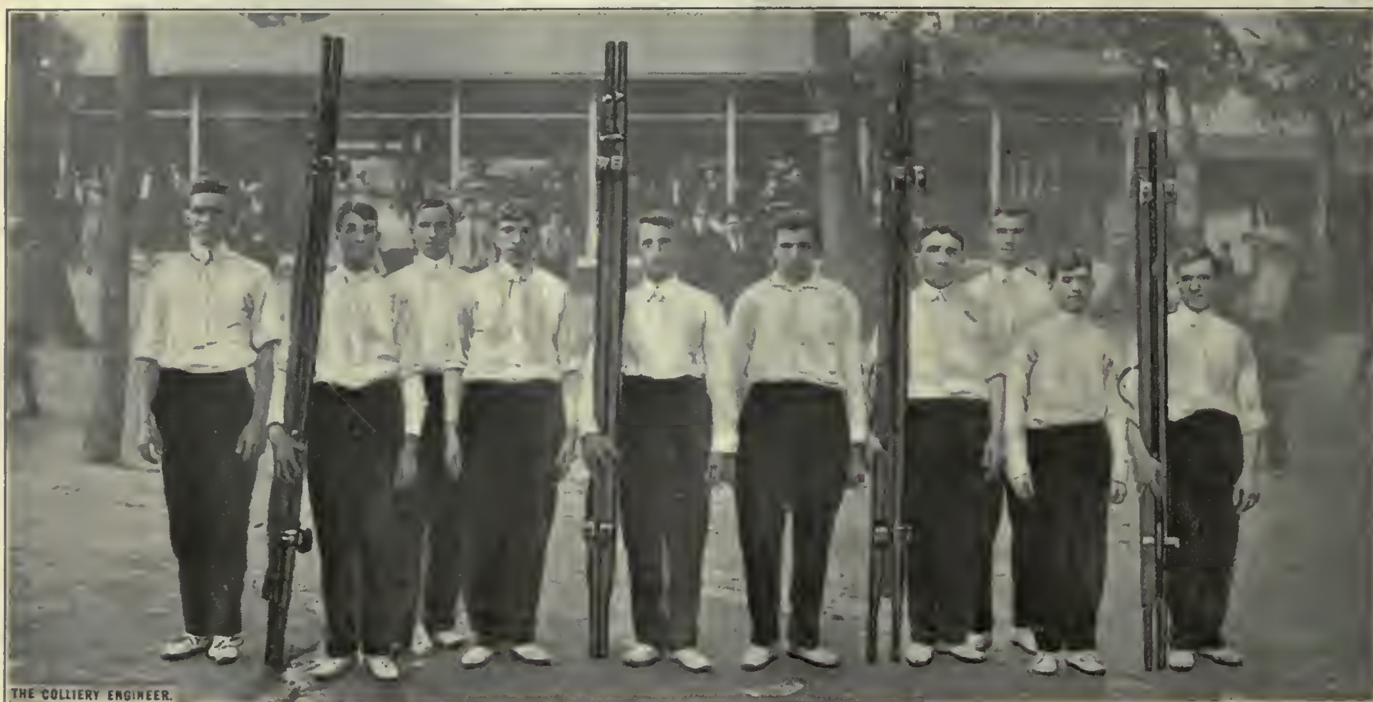
All the teams from each one of the four districts first entered into competition between themselves, after which the winners of the district competed in the finals. The winner of the Wilkes-Barre district pennant was the Stanton Colliery Outside team, the members of which were Frederick Harkins, captain, Anthony Monahan, John Minnick, Martin Bubbie, John Flaherty, and John Lavan. This colliery team won the pennant last year.

In event No. 2, in which Plymouth district teams competed, the Parrish Colliery Inside team won with a mark of 99. This team won the pennant last year with the same men on the team with one exception, Samuel Davis taking the place of David Jones. The line-up was as follows: W. J. Jones, captain, William Morris, Joseph Nicholas, Wade Maxwell, Edward Loughlin, Samuel Davis.

Teams from the Ashley district next competed, and Wanamie Colliery Outside won the pennant. Men composing this team are Irvin Vandermark, captain, A. L. Engler, Charles Womelsdorf, Oscar Spaide, Theodore Womelsdorf, John E. Burke.

The pennant-winning team of the Honey Brook division was the Audenried Colliery Outside corps. This makes two consecutive years that the Audenried colliery won the pennant, a remarkable feature because Captain Mader has three new men on this year's team. The members of the corps are T. O. Mader, captain, E. E. Stauffer, Frederick Schaar, James Roberts, Philip Lewis, George Schaar.

The bronze medal championship event was won by Parrish Colliery Inside team, so that the Nottingham Outside team would like to know what the Parrish Inside team know about outside first-aid work?



Litter Drill Team, Lehigh & Wilkes-Barre Coal Co.

Probably the event which created the most enthusiasm was the Breaker Boys' contest. Dr. J. W. Geist has given much time to instructing the breaker youngsters in first-aid work, and this year eight teams from the various districts competed. The men from the different collieries "rooted" for their own boys, some of whom had their subjects bandaged until they looked like real dollies. The work was so good that the judges, Drs. D. H. Lake, of Kingston, and J. H. Hughes, of Nanticoke, had the teams and the subjects parade around the pavilion. The Wanamie colliery boys, Walter Shershing, captain, John Craig, Thomas

Crouse, Stanley Shershing, Frank Stoj, and John Garvey won the pennant, by bandaging the fingers, hands, wrists, elbows, arms, and shoulders with 2-inch rollers, using spiral reverse and spica; and doing a Barton bandage on the head.

Doctor Geist introduced a new feature in the exhibition litter drill, which consisted in handling the stretchers and the subjects in various ways.

The pavilion was crowded, but about 800 were able to take luncheon and listen to the speeches. A. K. McClintock, Esq., delivered the chief address, and the Handel male chorus of Plymouth sang several selections.

Parrish Colliery Inside Team

Wanamie Colliery Boys Team

Ellsworth Collieries Co.

The third annual outing of the Ellsworth Collieries Co., held at the Ellsworth athletic grounds, September 22, was a gala day in which the public-school children, the first-aid corps, the rescue corps, and the Ellsworth-Cokeburg bands demonstrated in their particular lines.

Besides the citizens of Ellsworth and Cokeburg, visitors and guests arrived on special trains from Pittsburg and Cokeburg, also in automobiles, until it was estimated that 4,000 people were on the ground.

The affair was under the supervision of Prof. E. E. Bach, sociological superintendent of the company, and luncheon was served the guests. While a company affair, the first-aid exercises were under the auspices of the American Red Cross Society, that is, the rules adopted by that society governed the contest with Dr. W. T. Davis, of Washington, D. C., as one of the judges.

The first exercise on the program was a visit to the public school, where the children sang songs and gave a fire drill, 500 of them leaving the building in 1¼ minutes without unseemly haste.

In the afternoon, long lines of school children, headed by the Ellsworth-Cokeburg Boys' Band, marched to the grounds where the exercises were held. They were accompanied by Boy Scouts, and Camp Fire Girls, whose duty consisted in keeping order, carrying messages, and serving lunch to the school children ensconced in the grandstand and bleachers.

George Lindsay, with Alexander McBurnie as assistant, had charge of the first-aid demonstration, the judges being Dr. T. W. Davis, Washington, D. C.; Drs. L. W. Hoon, G. K. Hays, and R. B. Stewart, of Monongahela; and Dr. J. W. Hunter, of Charleroi.

Thirty teams were entered and six problems worked.

One of the most interesting of the day's exercises was a first-aid demonstration by six boys averaging less than 11 years of age. Their work was exceedingly good, and it is probable that the team is the youngest in the country although other school children are being taught the subject.

Because of the lateness of the hour, only one mine-rescue event was given. In the explosion of an experimental mine the place was filled with smoke and deadly gases and a man was under a fall of slate. Men equipped with oxygen helmets, after experimenting with a canary bird, entered the mine, recovered the man, and resuscitated him. The judges of this event were C. G. Brehm, of the Oliver-Snyder Steel Co., and W. W. Fleming, of the Republic Iron Co. The exercises were brought to a close when 200 men who had entered the lists marched past the commissary tent, where the domestic science girls handed them plates of dainties which they had prepared. There was neither fudge nor nabisco in the menu. Among the guests and the audience were a number of ladies, who are yearly taking more and more interest in these affairs.

Among those present were: E. A. S. Clark, New York City, C. H. McCullough, Jr., Buffalo, president and vice-president of the Lackawanna Steel Co., and W. A. Luce, assistant general manager of the Ellsworth Collieries Co., with their wives. Others present were: Mr. and Mrs. George W. Burleigh, of New York City; Chief Engineer W. A. James, of Buffalo, N. Y.; Dean W. R. Crane, of the State College School of Mining; E. C. Roberts, of the New Bethlehem Coal Co.; L. R. Crumrine, county superintendent of schools; Mr. and Mrs. Walter Calverly, of Pittsburg; Director F. M. Ball, School of Industrial Education, Pittsburg; Mr. and Mrs. J. A. Wylie, of Washington; Mr. and Mrs. Ross Dravo, Mrs. Frank Dravo, Betty Dravo, Mrs. Joseph Todd, Mrs. James E. Brown, all of Sewickley; Mr. and Mrs. H. H. Patterson, of Pittsburg; and Mr. and Mrs. Jesse Sanford, of Carnegie.

Auchincloss D., L. & W. Team, Winners Woodward-Pettebone Contest

Woodward-Pettebone Meet

The second annual first-aid contest held under the auspices of the United First-Aid Corps of the Woodward and Pettebone mines of the Delaware, Lackawanna & Western Railroad Coal Department, took place at Harvey's Lake, near Wilkes-Barre, Pa., August 15, 1914. Charles Enzian, mining engineer of the United States Bureau of Mines, had complete charge of the contest. Sixteen teams took part, most of them being from D., L. & W. mines. Two of them were boys' teams who attracted much interest and won admiration by their neat and efficient work.

There were three problems, all full-team events for men's teams, two problems for the boys and one special event for the captains of the teams.

The first prize of $50 in cash was won by the Auchincloss (D., L. & W.) team, who averaged 98⅔ per cent. This team was composed of Timothy J. Condon, John H. Keating, Reese Jones, James H. Jenkins, Thomas Chamberlain, and Gomer Davis. The illustration shows them in order given, beginning with H. H. Hitchings, mine foreman, on the left, and ending with H. G. Davis, district superintendent, on the right.

The second prize of $25 was awarded to the Harry E. team of the Forty Fort Coal Co. with 98 per cent. The third and fourth prizes of $15 and $10 were won by the No. 1 Slope and the No. 6 Slope teams of the Truesdale colliery, respectively, each with 97⅓ per cent., the former winning the third prize on time. In addition, each captain of the four prize winning teams received a safety lamp and each member of the first-prize team received an acetylene lamp.

The boys' events open to boys' teams, all under 17 years of age, had but two entrants. The Bethesda team won first prize with 97½ per cent., and the Truesdale team second. The prizes awarded were $15 and $10, respectively.

A special event open to the captains of the men's teams only, was won by Isadore Hochreiter, of the Harry E. team; John Cummings, of the Shawneeite team, of the Lehigh & Wilkes-Barre Coal Co., won second. Safety lamps were awarded to both. Each averaged 99 per cent. and the decision was made on time.

The judges were Dr. D. G. Robinhold, Dr. Charles L. Shafer, Dr. J. A. Smurl, Atherton Bowen, Bruce Dimmick, and Jesse Henson.

First-Aid in Northeastern Pennsylvania

Seven of the largest anthracite producing companies now hold annual first-aid contests in the summer and fall, and all have men trained in the work. There is also an intercompany contest held under the Red Cross Society of Pennsylvania. Last year there were between 300 and 400 teams entered in the various contests.

Dr. George H. Halberstadt, who directs the Reading first-aid work, believes in making it a preventative as well as a cure. Several weeks ago his men treated two cases of heads crushed between mine cars. Both of the victims were treated in the Frackville Hospital, and Doctor Halberstadt used the accidents for the text of a talk to the mine workers. There have been no cases of similar accidents in that locality since.

No more graphic description of the actual work of first-aid men has appeared than that written by H. I. Silliman, editor of the *Pottsville Journal*. In brief sentences he explained why thousands of mine workers have devoted their time,

and the officials of the company have devoted both time and money, to the development of this first-aid work.

"The mine hospital," he wrote, "is located at the foot of the slope or shaft. It is formed of concrete or some fireproof material and whitewashed frequently. The equipment consists of several cots covered with blue army blankets, litters, and first-aid cases. In one corner there is a telephone which connects with various parts of the mine. There is a man constantly on duty at the hospital.

"The telephone rings. A man has been injured by a fall of coal in this or that lift. The hospital man quickly summons the first-aid corps, the members of which are working in various parts of the mine.

"In a little recess in the rocky walls lies the crumpled form of a miner. He is groaning pitifully. The first-aid men take their positions. Every move is made with military precision. The man's leg is crushed and fractured, and he is bleeding. He is placed on a litter. The trousers, shoes, and stockings are cut off and a tourniquet applied.

"While the two men are doing this, two more are preparing splints. The men are working in the orange glow from the little safety lamps which the miners who have gathered around are holding. From up in the heading there comes the dull roar of a blast. The captain looks at a man and nods his head. The man nods in reply and hastens away. He is going to tell the man in the heading that a man is seriously injured and that they shall not shoot again until told.

"The setting of the fractured bone and the dressing proceeds. Hardly a word is spoken. What strikes one is the infinite tenderness of the men. They are doing everything possible to make the patient comfortable. When they do speak, which is infrequently, their words are those of cheer and encouragement.

"The injury has been dressed and the man says he feels better. 'Prepare to lift,' the captain commands. His men take their places at the handle of the litter. 'Lift,' he commands, and the litter is raised gently from the ground. 'March,' is the next command, and the men swing down the narrow passageway with military step, the captain marching at the head of the injured man.

"The man at the hospital has telephoned to the top to have the ambulance in readiness, and it is waiting when the cage reaches the surface. The injured man is placed in the ambulance. The captain and one other of the corps climbs in. At the captain's command the horses are started at a gentle gait for the hospital. Upon their arrival there the captain reports to the surgeon in charge the result of his diagnosis and what has been done. Returning to the mine, he records the case in the hospital log."—*P. & B.*

Somerset, Pa., First-Aid Meet

The State Young Men's Christian Association has for years stimulated, organized, and conducted first-aid meets in both the anthracite and bituminous coal fields. A meet was held by the committee at Somerset, Pa., Saturday, July 25, when 54 men, actually employed in the mines, gave a most creditable demonstration of the methods of treating different severe accidents. There was a large crowd of spectators, including many mine operators and miners from the surrounding coal district.

The one-man event, miner overcome by gas and wounded, was won by Victor J. Olsen, of Ralphton. The two-man event was tied by five teams. When a second problem was worked by these, there were still two tied and by another problem Messrs. David R. Spence and Clay Beynon, of Meyersdale, showed their superiority over the Acosta men.

Bethesda Boys Team, Winners at Woodward-Pettebone Meet

In the three-man event, six teams tied on the first problem. Of these, four remained after the second, and on the third trial the Meyersdale team again won, Messrs. Elmer Barnhart, David R. Spence, and Clay Beynon, demonstrating.

As is natural, the greatest interest was shown in the team competition. The problems given were:

Shot firer caught by flying coal, right eye injured, right collar bone broken, cut on right forearm; improvise stretcher and carry.

Powder keg exploded, burning miner severely on face, neck, chest, back, and both arms; carry 50 feet with improvised stretcher.

Man has a broken back from fall of roof; improvise and treat.

In the average for these events the teams stand as follows:

1. Somerset Smokeless, Boswell No. 2, 100.

2. Jenner-Quemahoning, Jerome No. 1, 99⅔.

3. Consolidation Coal Co., Acosta No. 1, 99⅓.

4. Jenner-Quemahoning, Jerome No. 2, 98⅔.

5. Somerset Smokeless, Boswell No. 1, 98½.

6. Consolidation Coal Co., Acosta No. 2, 98⅓.

7. Consolidation Coal Co., Meyersdale No. 1, 97⅔.

Boswell No. 2 Team, Somerset Smokeless Coal Co.

7. Consolidation Coal Co., Meyersdale No. 2, 97⅔.

8. Quemahoning Coal Co., Ralphton, 94⅔.

Prizes were given in each event. The American Mine Safety Association gave medals to the winning team. The American Red Cross awarded certificates to each winner of a first prize. The judges were all doctors approved by the American Red Cross.

The United States Bureau of Mines sent as instructor Mr. A. W. Harris, who trained the teams thoroughly in practical methods, using as much as possible such material as could be easily found at the face of an ordinary mine. Several unusual types of improvised stretchers were used, and the treatment of broken back taught by Mr. Harris was not only extremely simple, but most effective.

The officials of the coal companies present, many of whom had not entered teams, were well pleased with the results, and the judges were highly complimentary in their opinions of the work of the teams.

Mr. Landis conducted the meet with a local committee composed of Samuel Steinbach, superintendent Consolidation Coal Co., Somerset; Richard Maize, superintendent United Coal Co., Boswell; and F. W. Cunningham, State Mine Inspector. H. J. Hill, of the Johnstown Association, served as recorder. There was an exhibition of rescue through gases by means of the mouth-breathing type of oxygen apparatus. A mine was constructed by using brattice cloth tacked on to a rough frame in the shape of a tunnel 4 ft. x 6 ft. and 100 feet long. This was entirely new to the great majority of those present.

Virgil Saylor, district attorney, gave an eloquent address on "Conservation," applying it to natural resources, to individual health, to measures for reducing the number of accidents, and to the prevention of suffering, deformity, and death by means of first aid. He touched on the unselfishness, the sympathy, the high sense of service required by or developed through the practice of first aid. Mine Inspector Cunningham spoke of the legislative requirements now incorporated in the mining code—demanding a knowledge of first aid on the part of motor men and others, and of the questions in this subject asked by those coming up for certificate examinations. He declared that demonstration of first-aid practice would be made a part of the oral examination for foreman and fire boss, and that in his opinion the next State Legislature would pass laws demanding an elementary knowledge of first aid by other classes of miners.

At the close of these addresses, prizes were given by Mr. Landis to the accompaniment of noisy applause, and the miners dispersed, promising a larger meet next year.

J. S. Wentz & Co.'s Meet

On September 5, first-aid teams from the Upper Lehigh Coal Co., Upper Lehigh, Pa., J. S. Wentz & Co., Hazle Brook, Pa., Maryd Coal Co., Maryd, Pa., and Midvalley Coal Co., Wilburton, Pa., held their first annual competitive contest at Upper Lehigh. Fortunately, ideal weather prevailed and the outing was enjoyed by participants and their guests. These collieries belong to J. S. Wentz & Co., and as it was the company's first affair of the kind, it was the first time that the seven teams entered had engaged in a competitive contest. The prize was a silver cup donated by D. B. Wentz, president of the company, that must be won three consecutive times before it becomes the property of any colliery team. This time it was won by the Upper Lehigh Inside team, five questions being selected from fourteen by Everett Drennen, vice-president of the Stonega Coal and Coke Co., Stonega, Va. After careful scrutiny of the list of problems, the decision has been reached that Mr. Drennen is a "good picker."

All teams made a creditable showing and received praise from Dr. George Halberstadt, of Pottsville, two weeks after the contest, which means much.

Dr. H. M. Neale, of Upper Lehigh, Pa., was chairman of the meet, and the following acted as judges:

Doctor Lathrope, superintendent State Hospital, Hazleton, Pa.; Doctor Biddle, superintendent Fountain Springs Hospital, Ashland, Pa.; Doctor Wainwright, of Moses Taylor Hospital, Scranton, Pa.; Doctor Halberstadt, Pottsville, Pa.; Doctor Montelius, Mount Carmel, Pa.; Doctor Hanlon, Hazleton, Pa.; clerk to judges, A. J. Kotch, Hazleton, Pa.

The instructors of the teams competing were: Doctor H. M. Neale, Upper Lehigh teams; Doctor Redelin, Hazle Brook teams; Doctor Cairns, Midvalley team; Doctor Bord, Maryd teams.

Messrs. Robert Klotz and W. A. Turnbach, of Hazleton, Pa., acted as official timekeepers and secretaries.

Immediately after the close of the first-aid exercises, luncheon was served in the grove adjoining the baseball park, where the contests were held.

Addresses were made by Hon. George D. McCreary, and Mr. D. B. Wentz, of Philadelphia, Pa.

Among those present were the following:

D. B. Wentz, president Midvalley Coal Co., Philadelphia; Hon. Geo. D. McCreary, Philadelphia; Everett Drennen, vice-president Stonega Coal and Coke Co., Stonega, Va.; Edwin Thomas, president Nescopec Coal Co., Catasauqua, Pa.; M. S. Kemmerer, Sandy Run, Pa.; T. M. Righter, vice-president Midvalley Coal Co., Mount Carmel, Pa.; T. E. Snyder, general manager, J. S. Wentz collieries, Hazleton, Pa.; T. M. Dodson, Morea Coal Co., Bethlehem, Pa.; K. M. Smith, Alden, Pa.; T. D. Jones, Mill Creek Coal Co., Hazleton, Pa.; W. H. Davies, superintendent Lehigh Valley Coal Co., Hazleton, Pa.; John Rohland, superintendent Lehigh Valley Coal Co., Hazleton, Pa.; A. M. Allen, master mechanic, Lehigh Valley Coal Co.; D. J. Roderick, inspector of mines, Hazleton, Pa.; John Curran, inspector of mines, Pottsville, Pa.; James O'Donnell, inspector of mines, Centralia, Pa.; Joseph H. Saricks, superintendent Wolf Coal Co., Freeland, Pa.; Robert Klotz, Hercules Powder Co., Hazleton, Pa.; William A. Turnbach, Hercules Powder Co., Hazleton, Pa.; George W. Wilmot, Wilmot Engineering Co., Hazleton, Pa.; J. P. Powell, superintendent of M. S. Kemmerer colliery, Sandy Run, Pa.

After luncheon, base-ball teams representing the four collieries held a tournament, with the result that Hazle Brook carried off the highest honors.

Upper Lehigh Inside Team

Explosion of Gas

At Westende Colliery, Duisburg District, the Beckstadt seam, which here saddles down under the fifth level, is worked by two inside shafts from the latter to lower seams. At the place of the accident, the seam was about 20 inches thick, and had an inclination of about 2 degrees, the roof and floor being of slate. Two parallel roads were being driven into the field. Ventilation was through the two shafts, the air being coursed so as to keep the working places supplied. It is supposed that the brattice cloths had been lifted or the air pipes interrupted in some way, so that the air could take a short cut from shaft to shaft without passing the working place. The five men at the face on September 11, 1911, probably noticing that the gas began to burn in their lamps, fled hurriedly, but were too late to escape. Their bodies were found in positions indicating instant death. Conjecture and the condition of the place after the accident went to show that in the lower part of the gallery the gas had merely burnt, while at the upper part it had exploded. A piece had been broken out of the glass of one of the benzine safety lamps, that was otherwise undamaged. It is supposed that the defect had existed before the explosion and that the gas had been ignited at this lamp. Experiments subsequently made with safety lamps of the pattern used showed that even when these were swung about in gas, no ill effects were produced. When, however, gas was blown against the lamps, the wire gauze became heated and fused.—*A. R. L. in Trans. I. M. E.*

As the leading coal producing state, Pennsylvania sets a good example in the small tonnage that is won by the powder without being previously undercut or sheared. In 1913, the quantity of coal reported as mined by the dangerous practice of "shooting off the solid" was less than 3 per cent. of the total output.

The Penalty of Ignorance

By R. T. Strohm

With their faith and their courage unshaken,
Men have bravely been delving for coal,
While the grim reaper Death from their legions has taken
A vast and exorbitant toll.
Though the miners were skilled at their labor,
And they seldom attempted to shirk,
Yet they knew not the methods of saving a neighbor
Who chanced to be stricken at work.

It was not that they thought of repressing
All attempts to alleviate pain;
But their ignorant efforts, instead of a blessing,
Too oft were a positive bane.
Oh, they tried to be soothing and tender,
And they meant to be gentle and kind,
But the succor and aid they endeavored to render
Was wofully, stupidly blind.

There is many a sorrowing mother,
There is many a sister or wife,
Deeply mourning for son, or for husband, or brother
Who still should be buoyant with life;
And the whole of their heartache and yearning
Can be traced to the absence of skill
In the help of the injured, and scantness of learning
In treating the wounded and ill.

But no more does their work lack direction
As they bind up the gash and the tear,
And their cleanness insures that no dirt or infection
Will nullify all of their care;
And their efforts no longer are futile
As they bandage the crushed and the burned,
For their methods have changed from the faulty and brutal
Because they have studied and learned.

Northeastern Pennsylvania Engineers' Society

At the regular monthly meeting of the Engineers' Society of Northeastern Pennsylvania, the industrial motion pictures of the National Tube Co. were shown and explained. These pictures in three films show the different steps necessary in the manufacture of pipe from prospecting iron ore to testing the finished product.

The first film shows the prospecting by drill; stripping and mining with steam shovels, loading the ore on cars, transporting and loading the 13,000-ton whaleback steamers in 30 minutes, and unloading them in 4 hours.

The ore is next shown as it is being transferred from cars to stock pile, then to furnace charging car, and its discharge into the furnace with the flux and fuel. The molten iron is shown running into ladle cars which carry it to the mixer, the Bessemer converters, and open-hearth furnaces. The second film shows the converters oxidizing the impurities, the soft steel being cast in ingot molds, the soaking pits, reheaters, billet treatment, and sheet rolling.

Spellerizing, or kneading the hot metal to render it less susceptible to corrosion is also shown, and then the two processes of making butt- and lap-welded pipe. The butt-weld metal is charged in flat strips into one end of the welding furnace and drawn out of the other end and through the welding bell.

The first part of the third film shows the method of making lap-welded National pipe. The bending of sheets, charging into welding rolls, sizing rolls, and finishing rolls scenes are followed by those of inspecting, threading, and the hydrostatic testing to 600 pounds internal pressure.

The motion pictures are exceedingly interesting to those who have seen the process, and therefore were more interesting to those who had not. The writer having seen them twice, could enjoy seeing them a third time.

Tests for Coal-Dust Inflammability

The tests made at Lievin in 1910-1911, for ascertaining the conditions under which clouds of coal dust ignite and burn, are useful in several respects. They may serve to clear up the question whether there is, or is not, any risk of certain flames, or sparks, igniting clouds of dust produced accidentally, as in the tipping of a coal car; they facilitate the understanding of coal-dust explosions and, being made by simple means and often repeated, they permit of increasing the number of intercomparable proofs, while also affording many samples for experiment.

Although it has long been known that a cloud of coal dust can be ignited by mere contact with a flame, the conditions required to bring this about, when desired, are not so easy to realize.

The experiments that were made at Altofts for determining whether a very rapid heating merely of coal dust was capable of evolving an appreciable quantity of volatile matter, showed that such was really the case; but the proportion was judged to be too small to exert much influence on inflammability of a coal dust.—*J. Taffanel, Annales des Mines, Paris, 1912, S. 2, V. 2, p. 80.*

Concrete City

A Comfortable and Pleasant Town for Delaware, Lackawanna and Western Company Mine Workers

Concrete City, the Delaware, Lackawanna & Western's model village near its big Truesdale colliery, was started in the summer of 1913, when 20 double houses were constructed around a central square 300 ft. × 410 ft. The which also lead to the front and side doors of the houses. The whole city is surrounded by a stout wire fence.

There is much kindly humanity in

Cement Houses in Concrete City, Near Truesdale Colliery, Pa.

houses are two-story structures, 50 ft. × 25 ft., with flat roofs, dark green trimmings and little red chimneys which make an agreeable spot of color. The construction is practically of solid concrete, molded in one piece, after the idea of Thomas A. Edison, but the houses were built according to another man's patented adaptation of Mr. Edison's idea. Floors, walls, ceilings, stairways, even sinks and wash basins, were made in a mold with "poured" concrete. The construction is such that, on occasion, the furniture may be removed and an entire house thoroughly washed out with a hose.

Each house contains eight rooms, has stationary wash tubs, a buttery, and a good dry cellar. The concrete being slow to heat, the houses are cool in summer and warm and dry in winter. Special precautions have been taken to prevent dampness. Little marquises supported by chains overhang the front steps which have flower boxes each side. A complete sewage system has been installed, and the square is bounded by shade trees and concrete walks the forethought which was expended on the interior fittings of the houses. Wooden strips are imbedded in the concrete floors so that carpets may be tacked down. Below the French windows, opening outward, window boxes for flowers are set in the walls. Window openings are generous, and there is plenty of light. The window and door frames and the doors themselves are of wood. There is ample space behind each house for a truck garden, and space in the cellar to keep a supply of coal.

The rent of these houses is $8 a month for single houses, and $16 for the two halves, or a double house. After the cost of administration, taxes, upkeep, and improvements on the property such as sewers, grading, concrete walks, and shade trees are paid, the income from it amounts to about 3½ per cent. on the investment. That the mine workers are not unappreciative is shown by the remark of a miner's wife:

"I paid $12 a month for a house not half as good as this over in Pottsville," she said. "The children are healthier here, the house is perfectly dry and cool, and it is easy to keep clean."

The man in the best position to judge of the value of this model village is the foreman of the Truesdale colliery, where the dwellers in Concrete City are employed. When asked if he thought it was a good investment, he replied:

"If all the people working at Truesdale were like the people living in those houses it would be much easier for me. Labor which has to come here by an early morning work train is much harder to handle. The houses attract the better class of miners who live in them happily and contentedly. We rent them at cost so we make no financial profit, but I wish I had a hundred more of them."

When this was written, red, yellow, white, pink, and blue flowers were blooming around the trim houses. They were blooming, too, in flower pots and in the first and second story window boxes, when in August two officials of the company awarded first, second, third, and fourth cash prizes for the best kept and neatest gardens and grounds.

John P. Evans received the first prize of $10, John Allen $5 for second prize, John Martin $3 for third prize, David J. Thomas $2

for fourth prize, and Benjamin Isaac secured honorable mention. It was not the value of the prizes as the value of the improvement to their surroundings that made practically every householder in Concrete City enter the competition.

This past summer a circular swimming pool with constantly flowing water was installed in one corner of the big central square, and on hot afternoons many of the children, some in improvised swimming costumes and some with the alarming lack of them that characterizes New York newsboys when they make a surreptitious dash into the fountain in City Hall Park, disported in its safely shallow waters.

Swimming Pool at Concrete City

There are between 80 and 90 children in Concrete City, and evidences of their presence abound: For behind this house there is a child's double-seated swing; in front of that a benignant collie prowls and smiles upon the tumbling infants; even all the rag dolls are not taken in every night, hence with its flowers and children, its freshly blossoming shade trees and young girls, Concrete City presents a pretty sight. —*P. & B.*

The Mexican Constitutionalists have confiscated six coal mines near Sabinas, Mex., owned by French and American investors.

The True Meaning of Safety First

"Safety first" is not merely a catchy phrase designed by mine managers to mislead mine workers and the general public. It is a significant phrase and means that the personal safety of mine workers is paramount to everything else. It means that the mine owners and mine officials who have joined the "safety-first" movement hold the value of human life far above profits and the value of property. It means that everything will be sacrificed to save a human life. The movement has spread amazingly and has been, in a measure, productive of good. That it has not been productive of infinitely greater results is due to ignorance.

It may be ignorance on the part of mine officials or ignorance on the part of mine workers.

It is ignorance on the part of mine officials when they assume that "safety first" means that safety is the first consideration *after* largest possible temporary production with least cost.

It is ignorance on the part of the mine worker who thinks rational precautionary rules and methods are merely adopted to oppress him, or to reduce his earnings.

In truth "safety first" not only means economy in human life, but it also means in many cases economy in operation to the mine owner and increased earnings and comfort to the mine worker.

In the case of mine workers employed on day's wages, the carrying out of precautions through their labor does not affect their temporary earnings in the least, but freedom from accident and consequent death or loss of time certainly increases their earnings in the long run.

In the case of men working by contract, the carrying out of precautions may result in a temporary slight diminution of some day or several days' earnings, but in a month's time the earnings will equal or exceed the average, because the mine worker will be laboring under better conditions and with a feeling of increased safety. In no instance has the rational adoption of "safety first" at coal mines cost the mine worker a cent. In every instance in which advanced safety methods have been adopted the mine owners have been called upon for more or less immediate expenditures. In many instances the expenditures have proved eventually to be good investments by reducing the losses due to accidents, but in some cases the expenditures have been additional cost. This, however, has not been objected to, as aside from the economical standpoint, the satisfaction that the management feels in greater safety to employes has been worth the expenditures.

To make "safety first" rules and appliances most successful requires cooperation on the part of mine officials and mine workers. Such cooperation is, in many instances, hard to obtain, owing to two causes: First, a vast proportion of coal mine workers in this country are non-English speaking men who do not always understand the true motive back of the movement; and second, a few designing trouble makers, for purposes of their own, play on the ignorance of the non-English speaking men and mislead them into thinking the "safety-first" rules are oppressive and made to either increase their tasks or limit their earning powers.

A good way to overcome the opposition of mine workers to rational rules, methods, and institutions would be to extend the duties of the members of the many excellent first-aid corps. These corps being made up of the most intelligent mine workers, many of whom speak another language, as well as English, should have each rule or method fully explained to them, and they should be enlisted in a campaign of education among their fellow workmen. They naturally have the confidence of their coworkers, and, as their membership in the first-aid corps shows their interest in the welfare of the other mine workers, they can in almost every case be counted on as willing instruments to spread the knowledge of the benefits of the "safety-first" rules and methods among the men.

Another good plan would be to have a competent man explain the objects and benefits of the system to the most intelligent of the foreign-born mine workers, and after showing them the advantages, have them assist in making clear to the less intelligent the fact that the "safety-first" arrangements are really for their good.

In many cases it will pay to enlist the cooperation of the clergy of the churches to which the non-English speaking men belong, and it should not be hard to get their cooperation. If they are not enough interested to give such cooperation, they have certainly missed their calling, as the province of every Christian church is to guard the safety of the bodies of its members as well as that of their souls.

Naturally when everything possible is done to insure safety and the workmen as a whole are giving full support and cooperation in the carrying out of the rules and methods, the great and important truth must be kept continually in their minds, that no matter how perfect the rules and methods may be, there will always be danger in coal mining, and therefore eternal vigilance must continue to be the price of safety.

Elimination of Haulage Accidents

*By A. N. Harris, Superintendent**

We are beginning the fifth year of active work in the prevention of accidents, and since this safety-first campaign was started we have learned that efficiency is the synonym of safety; hence, efficiency, we say, is the longest step in accident prevention. By the application of efficient methods to the matter of motor haulage we have practically eliminated accidents from this department. The first move toward accident prevention in this line was allowing more space between the cars and rib; in other words, by making the haulage headings uniformly wider. The next was the standardization of equipment and the application of intelligent methods to handle the traffic, and these reforms introduced many others, even to grading and improving the haulage roads, grading overhead trolley wires, installing electric lights along the entries and furnishing better lighting facilities on the motors, all of which have increased efficiency and decreased accidents. It has got to the point that whenever a man is hurt or an accident of any kind occurs in the transportation by motors, some one is directly responsible for the occurrence, and by placing responsibility, other seemingly smaller details liable to cause accidents have received the same attention.

To have a well-regulated traffic system in a coal mine there is nothing more necessary than a clean, unobstructed roadway. Pieces of slate, timber, or other material should not be allowed to accumulate there any more than along the streets in a city; the roads must be ballasted, leveled, kept straight and in as good condition as any surface railroad. Men have been killed and injured by falling over loose material left along the roads and by wrecks due to poorly constructed roads. There should be plenty of electric lights placed along haulage roads so it would be unnecessary for a man to carry a hand lamp, and the motors should be equipped with arc lamps. Accidents have resulted directly from the lack of such facilities, and to my mind there is nothing in this line that adds to the efficiency and safeguards transportation in underground work like plenty of light. With light we can see ahead and detect danger; we can see any foreign material that has been carelessly left along the road. Another essential feature is the care of haulage motors and foreseeing breakdowns. Formerly we remedied the trouble, temporarily, after the breakdown occurred, but the principles of efficiency and safety have taught that is is easier to adhere to the old maxim of an ounce of prevention being worth a pound of cure, by preventing the breakdown. The greatest efficiency lies in the ability to foresee, rather than to see and remedy afterwards. Then the car equipment is another important matter. I have experienced more trouble and congestion from the lack of a few coupling pins than from any other thing in the haulage system, and I might add, in the transportation system of a coal mine. If a dozen cars are without pins it will delay transportation throughout the entire mine. It will start an endless chain of detaching the pin from the next car until your whole equipment is ready for the shop. By having a system of inspection, these annoyances can be reduced to such an extent that no trouble will occur if a pin does break. Whenever a car is in need of repairs, no matter how trivial or unimportant, it should be repaired at once and in this way the possibility of accidents and wrecks prevented.

Transportation by motors, like any other work, requires the cooperation of every other department to make it efficient and free from accidents. If the driver fails to couple the cars when delivered to the side track or the tipple men fail to perform their required part of the work, the system will be a victim of inefficiency. We must become in-

*No. 4 mine of the United States Coal and Coke Co., Gary, W. Va. Read at the Safety Boosting Banquet.

oculated with the germ of enthusiasm if we would free ourselves from the responsibility for accidents or reach the point where we can claim the distinction of being efficient. So set the germ of enthusiasm afloat in your efforts to attain efficiency and prevent accidents in your transportation department, as well as other departments of your work, and the year will bring just what you strive to attain.

The Prevention of Gas or Dust Explosions

*By J. R. Booth, Superintendent**

Coal dust is a source of danger in bituminous coal mines. The dry dust has such power to spread an explosion that it is more threatening and deadly to the miner than firedamp.

Although many miners and mine operators believe the dust of bituminous coal would ignite from an explosion of firedamp, nearly all of them contended that the dust in a mine free from gas would not explode. Consequently, in many mines in which no firedamp would ordinarily be detected, miners paid little attention to accumulations of coal dust, and some terrible explosions have taken place.

Firedamp carries its own warning —the "cap" in the safety lamp—but coal dust, though visible, does not attract attention unless present in large quantities. Firedamp rarely spreads through wide areas in a mine, and, except in notable and very exceptional cases, is controllable by means of the ventilation currents.

If by mischance a large body of firedamp is ignited, the force of the explosion is terrific, but the effect is localized unless dry coal dust is present. Dust accumulates everywhere in a mine that is dry, while gas commonly enters mine workings by numerous small blowers or feeders from the coal seam, the roof, or the floor. In most mines the quantities that enter are so small that if the ventilating current is sufficient and is properly controlled, the gas is diluted and carried away harmless. Only some of the mines in foreign countries and a few of those in the anthracite regions and the West of this country are subject to great bursts of gas into the workings. When such occur they must be met by special methods.

Only a few years ago many persons believed that coal dust would not explode unless there was some gas in the air with it, but those who have seen the tests of the past few years in the explosives gallery of the Bureau of Mines station at Pittsburg, and in the experimental mine near Bruceton, Pa., can have no doubt that a cloud of coal dust will explode without the presence of gas.

Explosions in the bituminous mines happen more often during the cold months. Cold air holds less moisture than warm air. The natural warmth of a mine raises the temperature of the air that enters cold in winter. As this air gets warmer it can absorb more water; it therefore dries the walls, roofs, floor, and any dust present, by taking up the moisture and carrying it out of the mine.

It is almost impossible to prevent dust being made in the working places of coal mines, for most coals break to pieces easily. The dust thus formed is apt to be dry, because coal seams generally carry little water. Even if some water soaks down from above and appears in the working, it gathers here and there in hollows, or "swamps," and as a rule the larger part of a mine that is not sprinkled or made wet in some other way, is dry during fall, winter, and spring.

Dust is made at the face in undercutting the coal, either by hand or with machines. Breaking down the coal after it is undercut makes more dust. If the coal is shot down, dust is made by the shattering action of the blast. In breaking lumps with sledges or picks, and even in shoveling up the coal, some dust is made. If the coal is "shot off the solid," it is badly broken, and much fine, dangerous dust is produced.

Since coal is easily broken, the making of dust at the face cannot be stopped. It is clear, however, that there are several ways of lessening the amount of fine coal and dust. To this end the coal should always be undercut or sheared, and if it cannot be wedged down and blasting is needed, each shot hole should be placed in the right spot and should contain only enough explosive to do the work. Care should also be taken in breaking lumps.

All fine coal cuttings or "bug dust" should be loaded into cars and sent out of the working places before shots are fired. There are two reasons why this should be done: (1) To keep the coal dust from being ignited by a shot; (2) to prevent the fine coal and dust becoming dangerous by reason of a blown-out shot or the ignition of a pocket of gas.

The chance of a shot of some long-flame explosive, like black powder or dynamite, starting a dust explosion is fearfully increased if the shot is tamped with coal dust or fine coal. Sometimes miners wet the dust or machine cuttings used for tamping in the belief that they can thus keep it from being ignited. There is little ground for this belief. If the shot is blown out, its heat instantly drives off the water, and then sets fire to the cuttings. Experiments at Pittsburg have shown that if coal dust tamping is wet it gives a flame only a little shorter than if dry. When 2.5 pounds of black powder and 2.6 pounds of coal dust tamping were used in a cannon the flame with dry tamping was 64 feet long and with wet tamping 50 feet long.

Sometimes miners use pieces of coal of nut size for tamping in the belief that they lessen the danger in this way. It is clear, however, that ramming or tamping such pieces will crush them, and that the shot will break the pieces still finer and perhaps ignite them.

The chance of a coal-dust explosion can be much reduced by using

*No. 10 Mines of the United States Coal and Coke Co., Gary, W. Va. Paper read at Safety Boosting Banquet.

explosives that have passed certain tests by the Bureau of Mines. If these explosives are always used under the conditions prescribed by the bureau, there is little danger of their igniting dust.

The presence of a small or large body of firedamp, the inflammation of which is an important cause in dust explosions, can be prevented by thorough ventilation. At some mines more air enters than is really needed, but not enough reaches the working places to sweep the face or to keep the gob free from inflammable gas.

Leaky stoppings, overcasts, and doors are responsible for the loss of air. A bad error in most coal mines in this country is the use of a single ventilating door in places where double or triple doors would prevent part of the loss of the ventilating current.

It is evident that while making dust in coal mines cannot be stopped, there are ways of keeping down the quantity. It is also clear that while any bituminous coal mine that is dry is liable to have a dust explosion, the chances of such an explosion can be greatly lessened. To entirely prevent dust explosions is more difficult, but they can be prevented by carrying out measures to keep the dust from igniting and to keep it in such condition that it cannot spread an explosion.

There are two ways of keeping coal dust from being dangerous. One is to wet it; the other is to mix or cover it with shale dust, clay, or sand. If the coal dust is wet enough it will not ignite; if there is enough unburnable dust mixed with it, a flame will not spread.

Swedish Artificial Respiration Device

By F. C. Perkins

When a person has been asphyxiated by gas, electric shock, or water, artificial respiration is often the only means of resuscitation. When the Sylvester method of artificial respiration is performed, the operator must work the arms for a long period before the patient shows signs of life. This is most trying work, and while the prone, or Shaefer, method* is not as exhausting to the operator, it frequently becomes very tiresome where one works over a half hour on his knees.

The device to produce artificial respiration, shown in Figs. 1 and 2, has been demonstrated to the satisfaction of the Association of Swedish Physicians and also by the life-saving bureau.

Fig. 1. Device in Operation

The apparatus consists of a lever, a board, a girdle over the patient's diaphragm that is tightened and loosened as the arms are raised and lowered by the lever.

In adjusting the apparatus shown in Fig. 2 the lever is extended and the patient placed on the board as in Fig. 1, after which the blocks are placed at the side of the patient's breast and the girdle over the diaphragm. The various attachments are next made to the girdle and lever; then the lever is lowered and the arms fastened loosely at the wrist with the palms of the hands upwards. The cross-bar is then fixed in place, but the arms must not be stretched so that the patient is drawn upwards on the board. The chain is then stretched and hooked to the free ends of the levers as shown in Fig. 1.

Fig. 2. Artificial Respiration Device

The work of respiration is begun by bringing the lever as far backwards as possible (inspiration) and then upwards and forwards toward the patient's breast (expiration). The ropes are strained when the lever is standing at right angles to the board. A further powerful drawing forwards toward the breast presses it together in order to produce a powerful expiration. The movements are carried on in time with the operator's own breathing or regularly about 16 times a minute.

*See The Colliery Engineer, Vol. 34, p. 53, August, 1913.

Elk have been found in the Uinta national forest, Utah, for the first time in many years. Since they are not from shipments from the Jackson Hole country to neighboring forests, the state and federal officials are gratified at this apparent increase in big game, as the result of protection.

How Mining Engineering Eliminates Accidents

*By J. R. Booth, Superintendent**

To attain efficiency there must be: First, a clearly defined plan, or ideal; second, an organization to carry out the plan, or ideal; third, the equipment of men, money, and materials to enable the organization to carry out the plan.

Mining engineering work consists mainly in laying out and supervising the work. Every one connected with mining has a more or less well-defined plan, or ideal, though he may not state it in so many words. In a large number of mines, this ideal is a large output at a low cost. While this is necessary to the success of any mine, the vastly more important ideal in engineering work is that in the mine there shall be no accidents.

While the fact is recognized that many accidents are seemingly unavoidable, in recent years, accidents which were formerly in this class have changed into the avoidable class, and we hope to see, by new methods and new discoveries, accidents which we now consider unavoidable partially or entirely eliminated in the next few years.

The first matter the engineer undertakes in mining work is the construction of a plan or projection for the mine. To do this intelligently, he must have the necessary data obtained from drill holes and openings. He must then, with the cooperation of the superintendent and mine boss, lay out a projection covering as plainly and in as much detail as possible the way the mine is to be worked and must keep in mind the ideal mine, the one in which safety will be the first consideration.

The endeavor in this must not be to barely keep within the mining law, but to have a mine which, by eliminating accidents of every kind, will draw the attention of the law makers and induce them to adopt and make our principles the law to govern other mines.

*Paper read at Safety Boosters Meeting, United States Coal and Coke Co., Gary, W. Va.

For efficient ventilation of a mine, the plan of ventilation must be made in every way as independent as possible of interference from any cause. A fan of sufficient dimensions to supply the necessary amount of air with a large margin of safety, must be provided. The airways must be laid out to be self-draining, or headings must be driven to drain them. The intake and return airways must have ample area, so that in case of a slate fall the air will not be blocked. To avoid trouble of this kind, the intake and return always must each consist of two headings. This will also permit them to be driven with stoppings between the two sets of headings, not less than 500 feet apart. Stoppings on permanent airways must be concrete or brick. Overcasts of a permanent character must be built, where necessary to split the air, in such a manner that there will be few doors, and to eliminate the danger of a broken stopping or a fall in the air-course or a room heading causing an air shortage over a large section of the mine.

The haulageways must be laid out as straight as possible and on as favorable grades as the conditions warrant. We believe the safest way to haul coal is to keep the motor at the front end of both the empty and loaded trips, and all our sidetracks are provided with runarounds for the motor so this can be done. Where the grades are not uniform, the headings should be graded to make them uniform. Where the roof is bad and it is not practicable to take it all down until good top is reached, concrete or steel work must be provided but no posts or wood are allowed on the haulage roads.

The rails specified should be not barely what you can scrape along with, but heavy enough to give you a track that will not easily get out of order. The ties must have face and thickness enough to prevent their splitting when spikes are driven into them. Curves must be of large radius and well made to avoid wrecks; plated frogs and spring switches must be provided, which will not permit a man to get in the way of a car when throwing the switch.

The wiring must be graded and protection boards provided at crossings.

The most important point in track work to avoid accidents is to keep the track perfectly straight by driving the headings on centers and laying the track to these centers. This eliminates the sideways motion of the car, which throws off coal, splits the ties, and causes the rails to spread and wreck cars. It also avoids wide places on the headings. Providing the haulageways with lights 150 or 200 feet apart will show up crooked track so it may be seen and straightened.

The haulage roads should be driven wide enough to permit a man to pass a trip at all points. Manways must be provided so the men will not have to travel haulageways.

A very important point in the lay-out of a mine for safety, is the concentration of the work in as small an area as possible. From our records we have found that the assistant boss is one of the greatest factors in keeping down accidents, and if we can lay out a mine so this assistant boss has less distance to travel for the same number of men, the layout will be more efficient, because it will make the assistant boss more efficient. He will have more time to devote to each miner and will be able to pay more attention to his drivers and day men. There will be less heading to watch and, by concentration, the coal will necessarily be mined quicker and not allow the roof time to get bad as it does after standing 6 months or a year. The ventilation for concentrated workings becomes easier to regulate, there being fewer stoppings to get out of order and no scattered workings in which the air-current may be neglected and gas collect. Another very important point in favor of concentrating work is that the fracture line for robbing can be kept in better shape. Robbing with an irregular fracture line is a

constant danger because it causes roof, otherwise safe, to become unsafe.

By giving prints of the workings and projections of his section to each assistant foreman and requiring him to keep them marked up to date, we try to keep before him the way the places should be worked so errors will be lessened, our curve headings driven better, and the robbing sections kept in better line.

All places in mines must be driven on sights. When, for any reason, the sight points fall out, the place is stopped until the engineers get them put in, to avoid crooked and wide places. A list of the points needed is made out by each assistant mine foreman and given to the mine foreman. He copies the entire list and sends it to the engineer's office that it may be gone over with the transitman so he may go direct to where he is needed when he goes to the mine.

The time limit of 5 minutes does not permit of enlarging or going into further details and makes it necessary to leave out the sanitation work or care of the men after they leave the mine and of their families, which is now one of the important points of the engineering work.

The Canadian Pacific Railway closed its coal mines at Hosmer, B. C. They will probably be abandoned, as were their Morrissey mines in the same district. The high cost of production is the reason.

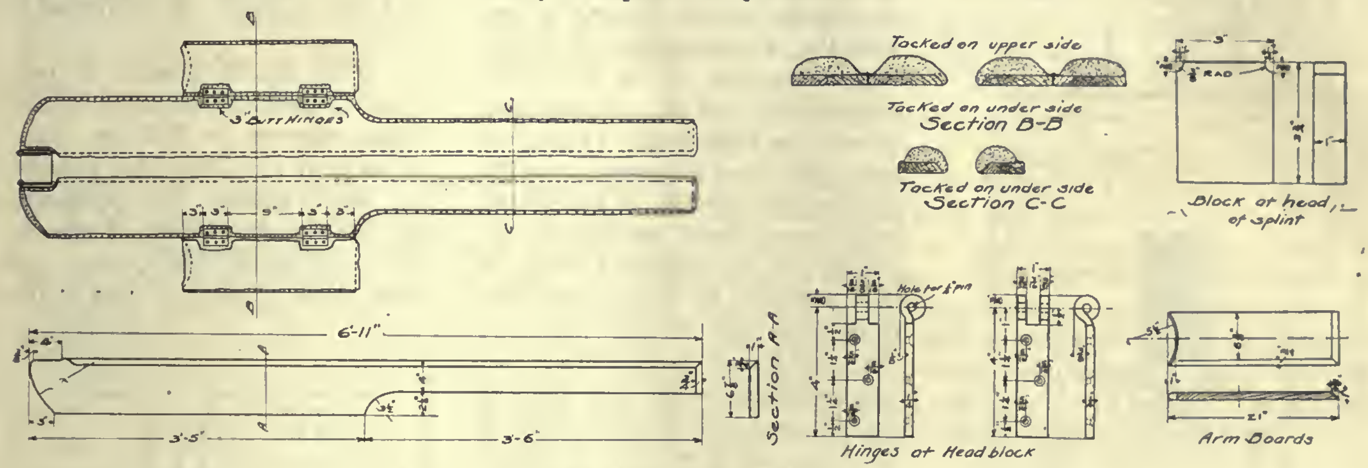
A Broken-Back Splint

Some time ago James Stewart, superintendent of St. L. R. M. & P. Co.'s mines at Van Houten, N. Mex., designed and built a splint which he called a "broken-back splint," although its uses were not confined to that one class of injury.

A most valuable feature was the ease with which the injured man was placed on the splint, but in reality the splint was placed underneath the patient. On page 32, Vol. 34, The Colliery Engineer, a detailed description of the splint is given. It immediately met favor with the Coal Department of the D., L. & W. R. R. Co., where it is being used in an improved form, the improvements having been designed by Dr. H. F. Smith, of Scranton, Pa.

Doctor Smith combined the two boards comprising the splint, by means of a block and two hinges at the head. Instead of the side boards which swing under the arms being hinged by straps he secured them with four iron hinges. The upper ends of these boards were curved in order to fit the arm pits comfortably; by means of the hinges the boards can be swung wide apart and placed on either side of the injured man and then gently placed underneath without unnecessary jarring of the patient. The accompanying sketch gives all the details of this new splint board. The patient is held, as shown in the photographs accompanying the description of the Lackawanna meet, by triangular bandages—one bandage being around the boards at the head, then caught up underneath and placed about the patient's head so that when it is tightened it will force his head down into the cushions, as shown in the photograph, page 172.

The padding of the board is made with moss or hair and covered with enameled cloth, which is waterproof and can be easily washed when soiled.



Plan of Improved Broken-Back Splint

New Coal Operations in West Virginia

A new coal operation is being opened in Boone County on Beach Creek, a tributary of the Little Coal River, by the Boone County Coal Corporation, of which J. C. Blair is the Charleston manager. This company owns large tracts of land in Boone County, and several mines have been operated on lease on its holdings for several years.

It is expected that the 2 miles of track necessary to connect with the Coal River branch of the Chesapeake & Ohio Railroad will be completed in about 5 weeks, and as soon as completed work will be begun on the tipple and the town. No name has yet been selected for the new town. The mines will produce No. 2 gas coal, and the workmen will be paid on the No. 2 gas scale.

The Boone County Corporation has leased 800 acres of coal land on Beech Creek to the Michigan & West Virginia Coal Co. This company is composed of Detroit capitalists. A mine will soon be opened on the tract.

A Firedamp Indicator for Miner's Electric Lamp

The problem involved in indicating gas when portable electric lamps are used in mines, has been attacked in Germany. The portable electric lamp is of the usual form, with an accumulator in the case forming the

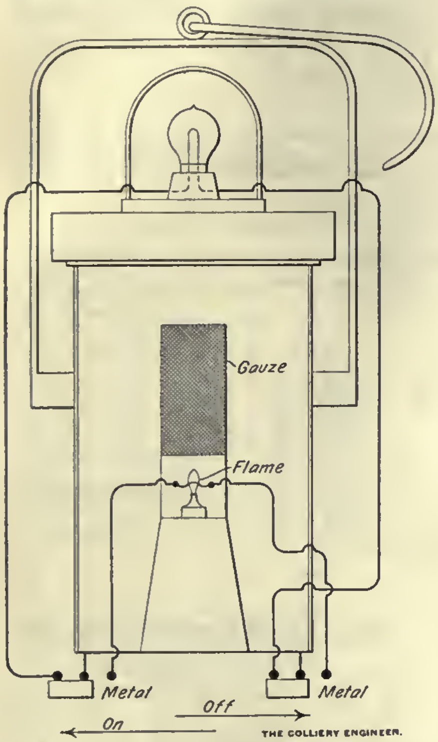


Fig. 1

base of the lamp, and the incandescent lamp protected by a globe on top, as shown in Fig. 1. The new feature is the addition of a flame lamp, carried on the side of the case, and arranged to be lighted for the short time that the test for gas occupies. The diagrams show the arrangement of the connections. The flame lamp can be fed with either one of the oils used in the ordinary miner's lamp, or with one of the spirits that have more recently been introduced. The flame is protected by a gauze, just as with the ordinary miner's lamp; and it is only intended to be in use for a very short time, so that there should be no danger of the gauze becoming heated, as it does where the miner is depending for his light upon the flame. At the slightest approach of heat in the gauze, the flame can be extinguished and the gauze allowed to cool down. The ignition arrangement is an adaptation of a very old one that has been invented several times, viz., a platinum wire passing through the vapor issuing from the wick of the lamp, which is heated to redness, when the lamp is to be lighted. The incandescent lamp is controlled by a circular switch, as in most of the portable electric lamps upon the market; and in the case of this particular lamp, the circular switch is made to perform the two operations; of switching the current on to the incandescent lamp, and off; and switching it on to the flame lamp. In practice, when the miner is going to test for gas, he first switches off the electric incandescent lamp, turning the upper part of the apparatus round, in the usual way, for the purpose. He is recommended to first switch off the incandescent lamp entirely, before switching on the flame lamp, so that his eyes will get accustomed to the dark. He then turns the top of the apparatus, and with it the circular switch, a little further; the current then passes through the platinum wire, and lights the wick. When the wick is lighted, the current should be switched off the platinum wire again.

It will be noted that there are three positions in which the current is cut off from the incandescent lamp, and three positions also in which it is cut off from the platinum wire which lights the flame lamp; also that there are two positions in which there is no connection between the battery, the incandescent lamp, or the platinum wire in the flame lamp. The different connections are made by simply moving the base of the lamp around.

Production of Explosives

"The Production of Explosives in the United States during the Calendar Year 1913" has just been published by the United States Bureau of Mines. The total production, according to the figures received from manufacturers, was 463,514,881 pounds (231,757 short tons), as compared with 489,393,131 pounds (244,696) short tons, for 1912.

This production is segregated as follows: Black powder, 194,146,747 pounds; "high" explosives other than permissible explosives, 241,682,364 pounds; and permissible explosives, 27,685,770 pounds.

These figures represent a decrease of 36,146,622 pounds of black powder and an increase of 7,212,872 pounds of high explosives and 3,055,500 pounds of permissible explosives.

In 1902, 11,300 pounds of permissible explosives was used in coal mining, whereas in 1913 the quantity so used was 21,804,285 pounds. The total amount of explosives used for the production of coal in 1913 was 209,352,938 pounds, of which about 10 per cent. was of the

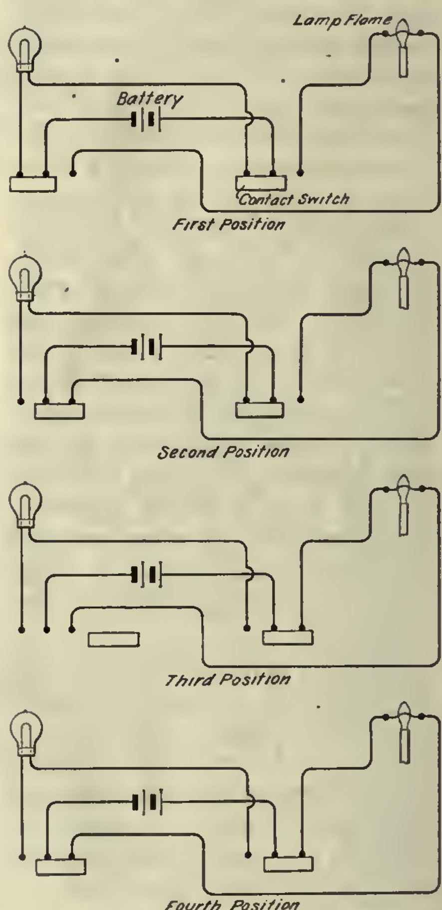


Fig. 2

permissible class as compared with 8 per cent. in 1912. The use of permissible explosives in coal mining has had gratifying results, and few, if any, serious accidents can be attributed directly to their use.

WITH THE EDITORS

AT A recent meeting of the Illinois Mining Institute, President Thomas Moses said: "Nothing pays so well in the coal mining business as prevention of accidents." This sentence expresses an important fact that should, equally with "Safety First," be always in the minds of mine officials. It is as true from the commercial as it is from the humanitarian view point.

OUTSIDE of coal mining regions, the mine workers are considered a rough, uncouth set of men. If the people who have such opinions of them could see the work of the numerous first-aid corps, and could realize the self-sacrifice and true bravery of the various rescue corps, they would speedily change their opinions.

Neither kaiser, emperor, king, or republic has better, braver, or more self-sacrificing men in their warring armies. Soldiers are brave in the glory of uniforms, waving flags, and the noise of battle, but the rescue corps men are braver still because they have none of the trappings of war or martial enthusiasm to carry them on. Their work is done in the dark confines of the mine, where unseen dangers threaten them. Besides, they fight the tremendous forces of nature to save lives, and not to destroy.

Coal-Dust Explosions

THIS is the time of year when coal-dust explosions occur. It, therefore, behooves all bituminous coal mine managers to humidify the air entering the mine, water dusty roads, use some simple means of wetting the face before shot firing, use permissible explosives, keep the road clean, and see that the air-current circulates properly. In gassy mines, mixed lights should not be used.

Birth of the First-Aid Movement

SOME years ago a prominent coal company executive, at the time the general superintendent of a large anthracite mining company, was at a colliery when an injured mine worker was brought to the surface. The injuries the man had received were not necessarily fatal, but during the time lapsing until he reached a hospital and proper surgical aid, preventible complications ensued which caused his death. The official was so convinced that with proper attention at the proper time the man's life could have been saved, he resolved that if he was ever in position where he had authority he would provide such attention to injured mine workers. Some time later, as general manager of a larger company, he tried the experiment with a trained first-aid corps at one of the collieries and finding its work productive of such excellent results, he established first-aid corps at all the collieries of that company. Almost simultaneously with him, mine officials of other companies started the work among their employes. Now the trained first-aid men at American collieries, if gathered together, would form a good sized army. The character of the work they do is evidenced by the oft-repeated remark of hospital superintendents: "If we could be positively certain that there was no danger of infection, we would not undo the bandages of the first-aid men because they are so well applied that we could not well improve on them, and in nearly every case the wounds are found antiseptic." All honor to the first-aid men and the mine officials who encourage them.

Foolish Opposition to Safety Methods

A LARGE and progressive anthracite mining company in Pennsylvania having learned that another company had secured excellent results in reducing the number of accidents in its mines, recently adopted the plan that had worked so well. The plan was the employment of a number of intelligent skilled men to continuously patrol all the working places and passageways in each mine and see that they were in a safe condition. In addition they took steps to immediately remedy dangerous conditions, and if the dangerous conditions was through neglect due to reckless indifference or ignorance on the part of an employe, that employe was directed and required to take proper precautions to save himself, and possibly fellow workmen, from injury or death. In other words, as the foremen and assistant foremen could not visit each working place more than once or twice a day, the company at considerable expense employed a corps of men at each mine to supplement the efforts of the foreman in securing greater safety for its mine workers. This action on the part of the company's management was quickly used by radical agitators of the I. W. W. stripe to stir up dissension among the organized mine workers, and a strike of some 18,000 men was threatened. Fortunately, before the strike occurred the more conservative intelligent officials of the miners' organization effectually squelched it. They recognized the true value of the patrol.

Recently another large anthracite company installed a checking system at a very large mine with many miles of underground gangways and chambers. The object was to safeguard the employes. By the checking system, if a mine worker did not come out of the mine at the proper time, his absence would be noted and a searching or rescue party could immediately be sent in to find him if lost in the labyrinth of workings, or rescue him if in danger or trouble. In addition, in case of accident the check-board showed the number of men in the mine, and there would be no chance of one or more being forgotten if it was necessary to call them out to protect them from danger. This precaution, also beneficial to the men, was used as a cause for dissension by trouble breeders. Fortunately, in this case, as well as in the other, conservative leaders, with intelligence enough to realize the value of the system, prevented a strike. But, in both cases there was considerable unrest among the employes and trouble for the mine officials. It is unfortunate that there is no legal way to suppress the trouble-breeding busybodies responsible for such occurrences.

Good Advice

RECENTLY a prominent Chicago coal operator called the writer's attention to several recommendations he would make to all operators, that are well worth considering:

First. Keep a modern system of accounting and have your books audited at least every 3 months by a certified public accountant.

Second. Have your properties frequently examined by a competent mining engineer.

The necessity for a complete and accurate account of the receipts and expenditures of a coal company is as strong as for a merchant, and it is required by bankers when asked for loans. Furthermore, conservation of the coal in mining, sufficient reserve pillars, good haulage and drainage systems, etc., when noted in an engineer's report, give additional prestige to the operator in the eyes of the man to whom he has appealed for money to conduct his operations.

But aside from the commercial view expressed by the first recommendation, is the effect of having some competent consulting engineer pronounce the mines in good condition.

Every loyal workman from the superintendent down at each mine will do his best for the good of all concerned, and this the operator well knows, but still there comes to him that comfortable feeling of security and satisfaction when he knows that an outsider has "passed on" the proposition.

Whether any coal operator takes these thoughts figuratively or literally, the result will be the same, that is, self-satisfaction in the knowledge that "a stitch in time may save nine."

American Mining Congress

The seventeenth annual convention of the American Mining Congress will be held at Phœnix, Ariz., December 7 to 11. Among the topics which will be presented to the Congress is one that seems to be affecting the western country particularly, and that is, "Opening to Development the Mineral Known to Exist in the Many Indian Reservations." Another question which will be given prominence on the program of the convention will be that of discussing compulsory arbitration.

It is hoped that at this congress a thorough discussion by those who favor and those who oppose such a law will at least be productive of suggestions that will lead to a solution of this vexing question and perhaps may result in bringing employer and employe into closer understanding.

The program for the entertainment of the visiting delegates is elaborate, including a trip to the Roosevelt Dam and the great smelting operations at Hayden and Ray. A large attendance of the metal mining men is expected.

Welfare Conference

In accord with the unanimous vote of the first Pennsylvania Industrial Welfare and Efficiency Conference held in Harrisburg last year, John Price Jackson, Commissioner of Labor and Industry, has issued a call for a second Conference to be held in the State Capitol, at Harrisburg, on the 17th, 18th, and 19th of November, 1914. This Conference is held under the auspices of the Pennsylvania Department of Labor and Industry and the Engineers' Society of Pennsylvania. The purpose of the Conference is to enable the employers and employes to work out together the great problems before them with reference to increasing the welfare of the employes and the prosperity of the industries.

Institute Meetings

The winter meeting of the Coal Mining Institute of America will take place December 8 and 9, at the Fort Pitt Hotel, Pittsburg, Pa.

Discussions on the following subjects will take place:

"Is the longwall method of mining applicable to the Pittsburg coal bed?"

"What is a safe voltage for use in mines?"

"Do compensation laws increase or decrease accidents in coal mines?"

"What are the advantages and disadvantages in the use of portable electric lights?"

T. L. Lewis and H. H. Stoek will deliver the after-dinner addresses. The second day will be devoted to reading and discussing papers.

The winter meeting of the West Virginia Coal Mining Institute will be at Huntington, W. Va., on December 9 and 10. It is expected that this will be largely attended.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Ventilation

Editor The Colliery Engineer:

SIR:—I would be pleased to see some of your readers answer the following questions:

1. In a colliery with two shafts each 1,000 feet deep and 15 feet in diameter, the temperature of downcast = 60° F., barometer 30″. Quantity of air going down the downcast 150,000 cubic feet per minute, the ventilation being produced by a furnace. Required the average temperature of the upcast, and the total horsepower necessary to produce the ventilation, assuming that of the workings minus the shafts to be 50 horsepower.

2. Whilst examining for gas near the roof, your safety lamp is extinguished without giving any of the characteristic indications of firedamp. What inference would you draw, and what would be the approximate composition of the gas?

A. C. D'ALTROY

Efficiency of Steam

Editor The Colliery Engineer:

SIR:—Because water remains at a constant temperature during boiling, a considerable quantity of heat is absorbed, the only effect of which is to transform the body from a liquid to a gaseous state. This phenomenon is one of the most interesting in physics because, according to Reynault, 965.7 British thermal units lie dormant in 1 pound of steam, and no one can tell the reason why.

On the condensation of a pound of steam into water at 212° F., 965.7 B. T. U. are released.

This is one of the reasons why the heat units that coal possesses and which are liberated under a boiler cannot all be converted into power at the engine but are lost in the condense.

According to the premises in your article in the October, 1914, issue of THE COLLIERY ENGINEER, 68.4 pounds of water should be converted into steam by 14,500 B. T. U., but they are not and I cannot find that you say they are. One of your contemporaries admits that water is converted into steam at 212° F. and then says your statement is wholly unintelligible and as it reads the calculation is wrong. To prove his contention he injects into the discussion steam boiler efficiency, which is entirely foreign to the subject. If he means to say that 53.8 per cent. of the heat units of coal under a boiler appear as useful work in the steam engine, he should consult a mechanical engineer, and then apologize to his readers.

W. L. A.

Pittsburg, Pa.

EDITOR'S NOTE.—We noticed the brain storm a certain editor was having; however, he will recover after he reads the article in question several times, and his system absorbs the facts which in his haste he overlooked.

Transportation Dangers

Editor The Colliery Engineer:

SIR:—I have read much in the last 3 years on "Safety First" and "Prevention of Accidents." But judging from the text of the articles the authors infer that only the men employed at the face are in danger. It is true that the majority of the accidents occur at the face, but naturally so because the majority of the men underground are employed near the face. In my opinion the runners, drivers, and motormen expose themselves to as much danger as do the miners and laborers, therefore, I think attention should be directed to them sometimes. About 13 per cent. of the accidents underground are caused by mine cars and locomotives, and when the difference in the number of underground workers is compared with the number of men and boys engaged in the transportation of coal there are proportionally as many accidents from cars and locomotives as from falls of roof and coal. Probably no subject is more important to the operator than the transportation of coal. It is therefore essential that all men in charge of the haulage should be masters in the business. The men in charge of the transportation in most coal mines are assistant foremen, and to them, from experience, I make the suggestions following: Be careful and always call the attention of your men and boys to the dangers that surround them. Caution the runners, drivers, and brakemen not to ride between the cars; not to uncouple cars on the fly, and not to ride on the head end of the motor. Caution the motorman against jerking and bumping the trips hard, as it damages the cars and spills the coal; advise the crews always to carry plenty of sand and also to carry a light on the head end of their motor. Provide car runners with sprags about 21 inches long, as the use of short sprags is the cause of many fingers and hands being caught in wheels, besides sometimes a spragger is thrown off his balance and falls under the wheels or is dragged by the cars simply because his hand or fingers are caught. Drivers and trip riders should not wear loose clothing or gloves with gauntlets, as these are likely to catch on something and cause the wearer to fall or be dragged by the cars.

Examine and see that all head blocks, safety latches, signal wires, etc., are in good working order. Numerous accidents have happened

to drivers riding on the bumpers of cars and sliding their feet on the rail, therefore if it's a long haulage road and the drivers have to ride on the head end of the cars, provide them with seats that can be detached. It is good practice to keep roads clean and in good condition, also to eliminate curves so far as practicable. Use judgment in placing boys and mules so as to distribute the work evenly among the men.

See also that the mules are harnessed properly; that the collar and harness are of the proper size; that the traces are of equal length; that the breeching is not carried too low, as a mule is like a man, if his clothes do not fit him he is uneasy and begins to kick and is likely to injure the driver; above all, see that there is plenty of clearance between the rib and the car. See that no props are stood close to the road. Where it is necessary to use chains to pull the cars to the face, see that the chain is kept in good condition, also provide the miner with a wheel block.

Many accidents occur to boys and mules because of the driver's light going out, sometimes because the miner has refused to give oil to the driver. I insist that all my runners and drivers shall buy their own oil.

Finally, do not let the boys beat the mules unnecessarily. There is a knack in handling mules just as in doing other things, and the best drivers get their work done without continually beating the mules. Aside from the question of abuse, beating a mule may make him vicious and more dangerous to those who come near him.

Mine foremen, it is your duty to see that what I have said in my letter will be carried out. Provide your assistant with what he wants, as the car of coal is what counts; be careful whom you hire, place the right man in the right place.

Superintendents, be careful whom you select to take charge of your mines.

Richard Bowen

Retreating Mining

Editor The Colliery Engineer:

Sir:—Having read the article on this subject in the October Letter Box, and having some experience of longwall and square work in coal mines, I thought it might be useful to G. E. L. to answer to the best of my ability with the experience thus gained.

I do not think the fact of the 9-foot bed of coal being worked 35 or 40 feet above this 4½-foot coal would have any appreciable effect on the workings underneath. True, where pillars are overhead, coal might be extracted easier underneath the pillars, as each particle extracted is bearing its own overburden, although the roof and overburden are mostly soft shale; the fact that ledges of limestone up to 3 feet thick are part of overburden between those beds of coal would strengthen the strata. No unequality of surface has much effect until the roof pressure is brought to bear on the workings by extracting the coal, and then if the place is properly gobbed and secured the overburden will gradually rest on the gob.

There are many shafts working four and five beds of coal with a distance of less than 35 feet between them. True, most of those are worked on the longwall advancing system which allows of a gradual sinking of the whole surface to meet the difference between what is extracted and gobbed by cribbing.

In the method of extracting pillars as shown, my opinion is that a great amount of these pillars would be lost by top overriding. Narrow roadways and large pillars should simplify the drawing outward of coal in pillars; the process would be in lifts or slabs of suitable size, each worked clear through to parallel roadways so that rails and timber could be taken out as soon as the slab of coal was removed and the whole allowed to cave in. By slabbing, the whole pillar can be removed with very little loss of coal, and narrow roadways could be secured against the cave-in coming so far outward as to trouble the getting away of the next slab of coal. Keeping the whole panel of pillars working at one time, regularity in the extraction could be accomplished.

John Shepherd

Glencoe, Ohio

Coal Washer Efficiency

Editor The Colliery Engineer:

Sir:—Is it practicable to obtain the washer loss in a coal washer from the proximate analysis of the raw coal, the washed coal, and the refuse; and is it practicable to obtain this same loss from the British thermal units of the same materials?

On page 80 of The Colliery Engineer for September, Mr. Newell G. Alford gives some data covering the washer operation of the St. Bernard Mining Co., at Earlington, Ky., in which he gives the washer loss as 16 per cent., which is considerably lower than obtained by either the proximate analysis or B. T. U. basis.

Mr. Alford gives the following analysis of the Earlington materials:

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B. T. U. Dry
Raw coal	4.81	35.35	40.77	19.07	4.18	11,019
Washed coal	15.80	32.84	42.39	8.97	2.82	12,755
Refuse	9.92	23.49	20.08	46.51	8.80	4,744

Changing the above analysis to a moisture free or dry analysis and combining the volatile matter and fixed carbon under the head of heat-producing units and disregarding the sulphur, we obtain the following analysis:

	Heat Units	Ash	B. T. U. Dry
Raw coal	79.966	20.034	11,019
Washed coal	89.347	10.653	12,755
Refuse	48.368	51.632	4,744

Of the 900 tons per day taken by the washer, 43.29 tons are moisture; 685.08 tons are heat units (fixed car-

bon and volatile matter); 171.63 tons are ash.

Of the above, part will go into the washed coal and part into the refuse, but the sum of the heat units in the washed coal and refuse will be the same as the heat units in the raw coal. The same will be true of the ash, but will not be true of the moisture, on account of the addition of water in washing; therefore, the moisture free analysis will have to be used:

Let a = heat units in washed coal;
b = ash in washed coal;
x = heat units in refuse;
y = ash in refuse.

Then
$a+x = 685.08$ tons;
$b+y = 171.63$ tons;
$a+b$ = washed coal in tons;
$x+y$ = refuse in tons.

From the analysis
$a = 8.387\ b$ and
$y = 1.067\ x$.

Substituting and solving we find $a = 590.097$ tons; $b = 70.359$ tons; $x = 94.983$ tons; $y = 101.271$ tons. The washed coal is 660.456 tons and the refuse is 196.254 tons; or, of the 856.71 tons of dry coal sent to the washer 77.09 per cent. is washed coal and 22.91 per cent. is refuse, or the washer loss is 22.91 per cent. instead of 16 per cent. as stated.

For calculating the washer loss from the B. T. U. of the dry coal:

Let x = per cent. of refuse or washer loss; $100 - x$ = per cent. of washed coal.

Then $100 \times 11{,}019 = 12{,}755\ (100 - x) + 4{,}744\ x$. $x = 21.67$ per cent. washer loss and washed coal = 78.33 per cent., which is only 1.24 per cent. difference from the proximate calculation.

Furthermore, what is the efficiency of the washer, granted that above figures are correct, and are the following efficiency calculations correct?

The washer has eliminated 101.271 tons of ash from the raw coal containing 171.63 tons of ash, or shows an efficiency of 59.01 per cent. in separating the ash, but it has also thrown into the refuse 94.983 tons of heat units of the 685.08 tons of heat units in the raw coal; this shows a negative efficiency of 13.86 per cent. in the washing of the coal; then the washer efficiency will be the difference or 45.15 per cent.

A theoretically perfect washer, that is, one with 100 per cent. efficiency, would be one that would separate the raw coal into heat producing units; i. e., washed coal and ash; i. e., refuse. Such a washer would, of course, be an impossibility on account of the inherent ash in the coal, and the volatile matter and fixed carbon in the slate and bone, but I believe such a basis for washer efficiency would give an equitable comparison of different washers under different conditions.

A. D. Macfarlane, E. M.
La Follette, Tenn.

The figures given in the operating data in Mr. Alford's article, with the exception of the information on sulphur and ash, are entirely independent of the comparative analysis. The determinations referred to by Mr. Macfarlane were obtained directly from that particular portion of the operation to which they relate. They are the practical results of the operation rather than deductions either by the proximate analysis or the B. T. U. method. Many difficult features surround the washing and cleaning of this Western Kentucky coal, making its discussion necessarily complex, but it is a very interesting one and we should be pleased to have our readers give their views on the matter.—Editor.

Welfare Work

Chief Henry has sent to each operator in West Virginia a letter commenting on the fatality list for July, in which he says in part:

"It may be of interest to know that, in an effort to reduce accidents, many of the operators throughout the state are hiring extra men, to be known as 'Safety Inspectors,' whose duties in no way conflict with the mine foremen's, but are additional protection, and where these men have been employed the accidents have been materially reduced.

"In addition to this, in a number of mines which liberate gas, the managements have installed electric lamps, strictly prohibiting the use of open lights. This demonstrates that the managements of these mines are endeavoring to protect the miners and laborers against the possibility of an explosion."—*P. & B.*

Making a Primer Cartridge

In a recent article in *Concrete-Cement Age*, Arthur La Motte describes a new method of making a primer cartridge, which is free from the objections to several methods now in use.

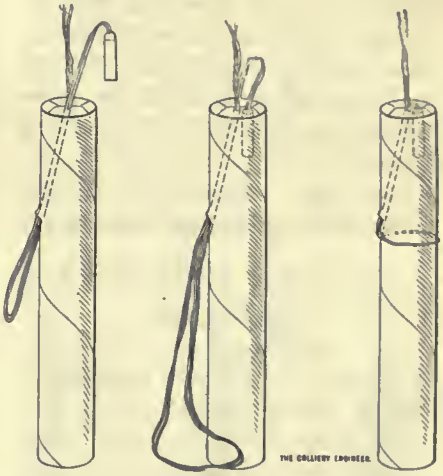


Fig. 1 Fig. 2 Fig. 3

Following are the instructions:

With a sharp pointed stick, punch a hole from the center of the top diagonally through the cartridge to a point about 3 inches below the top. Double over the electric blasting cap wire about 18 inches from the cap and push this doubled end through the hole from the top and out at the side.

Make a loop of the portion projecting and pass it around the cartridge, Fig. 1, punch a hole in the top of the cartridge about ½ inch from the point at which the wires enter and insert the detonator, Fig. 2. Bring the wires tight and the result is a primer which holds perfectly, Fig. 3, and one in which the wires do not cross each other under tension as in the ordinary method of taking a half-hitch with

the wires around the cartridge. This latter practice is liable to make a short circuit and lead to a possible misfire. This method is not feasible with fuse.

Jones Anchor Cartridge

Many lives are lost in mines and quarries through misfires, and so-called premature explosions. The majority of these are due directly to faulty priming. To this may be added the fatalities among farmers using dynamite for agricultural purposes, which will soon equal in number those in mines and quarries unless proper instructions and suitable means of priming are furnished them. It seems incredible that for so long a period the workman has been supplied with dynamite in one hand and an exploder in the other without safe means of connecting them.

The safe method of priming shown in Fig. 1 requires cartridges to

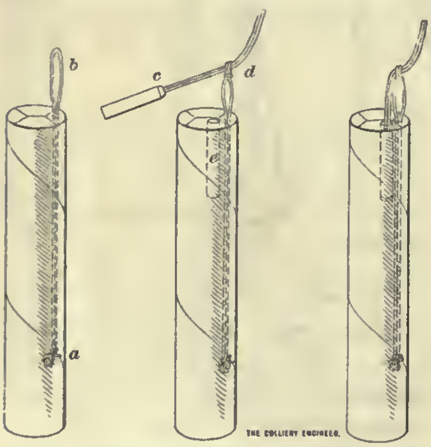


Fig. 1. Anchor Cartridge

be furnished by manufacturers with an "anchor" forming the projecting loop *b*. A clove hitch is turned on this loop, the exploder passed through it, and the knot tightened as illustrated at *d*. The hole *e* is punched to receive the exploder *c*, which is inserted in cartridges as shown.

The strain comes altogether on the anchor. This kind of priming does not increase the diameter of the primer, and where a cartridge goes this will follow without forcing.

This device if used will to a large extent eliminate accidents due to faulty priming, such as priming in the side, etc.

A fatal blasting accident generally costs in dollars a sum that will keep an ordinary mine in explosives for some years.

The adoption of this "anchor" priming device means a trifling expense to manufacturers.

Coal and Iron Industries In the War Area

The scene of the earlier struggles of the war now being waged in Europe is the center of the coal and iron industry in Belgium.

In 1913, the Belgian coal output and the district in which it was mined was as follows:

District	Tons
Mons	4 409,000
Center	3,461,000
Charleroi	8,147,000
Liege	6,011,000
Namur	830,000
Total	22,858,000

The Mons district has about 20 collieries. The Charleroi district has about 20 operations. The Liege district has approximately 40 companies.

The Minette iron ore district of Alsace-Lorraine which in 1912 produced 45,000,000 tons of iron ore is in the trouble zone as is Luxemburg and that part of the district which extends into France.

The Meinthe and Moselle districts in France have Nancy, Longwy, and Briey as iron ore producing centers. In 1912, Nancy produced 1,973,986 tons of ore, Longwy 2,452,655 tons, and Briey 12,699,240 tons, making a total production of 17,125,881 tons.

The Valenciennes coal district in France is involved and the Saar River district in Germany will be in all probability affected by the military operations.

The Rheinish-Westphalia coal district is up to this writing undisturbed by the enemy.

Half-Hitch Fuse Anchor

In view of the fact that the La Motte method of priming is not suitable with fuse, and at the present time Jones Anchor Cartridge is not to be had in every location, it is suggested that the following hitch be tied when using blasting caps and fuse:

Put a piece of strong string around the cartridge with a half-

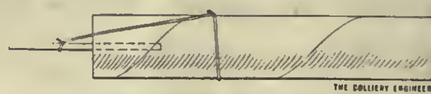


Fig. 1

hitch, as shown in Fig. 1, leaving the other end long enough to put a half-hitch around the fuse. When both half-hitches are pulled tight, the strain on the fuse where the cap enters the cartridge and where the fuse enters the cap should be removed.

OBITUARY

STEWART KENNEDY

Stewart Kennedy, president and manager of the Model Coal Co., at Sheridan, Mont., committed suicide early in October. Mr. Kennedy was well and favorably known in the anthracite fields of Pennsylvania, where he gained his early experience as a mining engineer, and in several bituminous fields in Pennsylvania and other states, in which he held important mining positions. In recent years he was engaged in the coal fields in the Rocky Mountain regions. On the morning of his death he informed his wife that he was going to the mine, but instead he went to the Mount Hope cemetery, near Sheridan, and shot himself through the left breast, causing instant death. Business difficulties and the unwillingness of eastern stockholders to advance money to finance improvements which he felt would increase the value of the Model Coal Co.'s property are given as the cause of his self-destruction. Mr. Kennedy was born and raised in Pottsville, Pa., in which town he acquired his early

education. He began his mining experience in the engineering department of the Philadelphia & Reading Coal and Iron Co., and later was connected with the Lehigh & Wilkes-Barre Coal Co. in the Hazleton field.

Elimination of Accidents in Loading Coal

*By W. W. Harding, Superintendent**

To eliminate the number of accidents in loading coal it is necessary to have the cooperation of the miner. Many mine workers are often ignorant of dangerous conditions, which makes it every one's duty to see that the inexperienced are intelligently instructed in regard to the hazards of their work. Some miners, even though experienced and realizing the dangers of the mine, have a habit of putting off, which makes it necessary to discipline miners who overlook dangers and put off setting posts or pulling down loose coal, rash, or slate. There is another class of miners that should be dealt with severely, because although thoroughly acquainted with the mining laws, company rules, and instructions, they wilfully disobey them. These men not only endanger their own lives, but also those of their fellow workers, and are a menace to the coal mining occupation.

The careless miner must be taught that no man owns his own life: That it belongs to his wife, his children, or to some one besides himself. It is a duty every man owes to himself to take care of his life, in order that the best interest of whomever it belongs to may be conserved. If this could be indelibly impressed upon the minds of every miner, then there would be fewer accidents in the mines and the careless miners would retire from business.

Mr. Harris, superintendent, of Nos. 4 and 5 plants, said a year ago, "are not we our brother's keeper?" If so, and we fail to enforce rules or adopt every possible precaution for safeguarding the lives and limbs of those in our care, we are culpable. Safety first to the efficient miner is an ideal which should fire his imagination and appeal to the best there is in him, as it means that he will not *think* his place is safe, but will by examination *know* it is. He will set the required post before loading a car; he will take down all loose coal, rash, and slate, and if in doubt at any time as to what to do to keep himself safe he will give the side of safety the benefit of the doubt.

Many no doubt are under the impression that efficiency has nothing to do with safety, but let me impress upon your minds that safety and efficiency are twin brothers. Work not efficiently done has not been done in safety, and work not done in safety has not been done efficiently. Speed is related to neither. The man at the face should be taught efficiency, so that he can earn from himself and society a better living.

Education is needed in the mining game. There are some who may say that education of the miner is not a need in the present-day mines. There is not a job around the mines, but that would be more efficiently done and handled with less waste, were the men who do it trained and taught to make their hands and brains work together. Put a spirit of pride in men's hearts and make good work a matter of discussion. In a way efficiency is the ratio of actual service to capacity or ability to produce. A miner at the face whose daily output of coal averages five cars, as compared with another, who, working under the same conditions, averages seven cars per day, is regarded by his foreman as being an inefficient workman, and perhaps it is no fault of his other than he does not perform his work in an efficient manner, although he works as faithfully.

Safety and efficiency should be taught in the schools, should be a topic in the homes where wives, mothers, and children may take part in safety campaign discussions.

Let us look at this question from another angle, and consider the duties of the mine foremen and their assistants, in eliminating accidents in the loading of coal. These men should be considered safety specialists. Why should we always be putting things on the miner, when our foremen also are known to have violated rules and instructions? Who should be the men to set the example for the miner? The mine foremen and their assistants, then why, should they not also be disciplined? The lapse of discipline causes a large percentage of accidents to the miner loading coal, and if mine foremen and assistants are permitted to disobey the rules, why then should the man at the face be censured for disobeying? Now, Messrs. Mine Foremen and assistants, set the example and there will then be fewer accidents in coal mining, as there is only one way to do a thing, and that way is the safe way.

*Paper read at the Safety Boosting Dinner of the United States Coal and Coke Co., Gary, W. Va.

Eliminating Electrical Accidents

*By Eli Clemens, Chief Electrician**

Efficiency in electrical engineering with a view to elimination of accidents would mean to make plans and specify equipment and material that would permit the maximum output with the least possible labor and material for good construction with the least possible cause for accidents. To secure these results we must have plans showing the layout of the mine or structure in which electricity is to be used. We must know in what capacity the power is to be applied and the amount and the voltage, then with the plans we can specify the material needed. Nearly all of you working for this company have instructions in blueprint form or in letters giving our standard size of wire, hangers, and other material used in the mine, as well as the standard way of installing them, so it will be unnecessary for me to say anything further on that subject.

*Paper read at the Safety Boosting Dinner of the United States Coal and Coke Co., Gary, W. Va.

In the last few years the demand for greater safety, higher efficiency, and simpler equipment has not stopped at the mine office, but has reached to the manufacturers, so that they have practically redesigned part of their products. A call was made for self-starting motors for small pumps and fans. These are on the market. Better section line switches and insulators were called for. These are now also in use. Better and safer motor-starting apparatus was in demand. They are now being furnished. Battery locomotives were desired; they are now being adopted for gathering purposes, and a few more years will see them being used for hauling, except, probably, on main headings or on long tram roads with heavy grades. Following this will be the battery motor for operating mining machines. These two developments will eliminate all wiring on room headings, but with these new developments new dangers will no doubt arise; however, they will be easily remedied.

The substitution of steel and concrete for wood is eliminating the fire hazard. Fully enclosed starting, controlling, and protective apparatus will eliminate many personal injuries. The manless automatic substation is receiving the engineer's attention. Labor is probably the most important item in the installation of any equipment, and as much depends on the workmanship as on whether an equipment is efficient or safe. Connecting two wires or cables is a simple operation, but to connect them so as to be electrically and mechanically as good as a solid wire or cable is another proposition. The insulation of a joint must be carefully done with screw and clamp connection, and care must be taken to see that all screws and nuts are tight. The forming and placing of wires in a limited space requires attention. These small matters in themselves are very often neglected, with the result that cables burn in two. Terminals also become unsoldered, screws work loose, and numerous other defects arise, which seemingly are so easily repaired that men very often are negligent or careless in seeing that the power is cut off, and proceed with a screwdriver, pliers, or wrench to make repairs. Shocks or burns are many times the result of these hasty movements. Track bonding in a mine is probably the most neglected piece of electric work, and yet it is of the utmost importance. The earth is a conductor of electricity of almost infinite cross-section, and varying resistance, depending on the contact and substance that the electric current encounters in completing the circuit. If then there is poor bonding in the track and you complete the circuit through the motors and controller, the current will take the path of least resistance to return to its source. This may be through the coal, or the substance above or below the coal, or both. In some cities so much trouble was experienced through poor bonding and insufficient copper for return that voltages of from 20 to 25 were recorded between return circuits and adjacent pipe lines. To a certain extent the same conditions may exist in mines, and since it requires only from 1¼ to 3 volts to set off a detonating cap there is a possibility that with a bare spot on the leading wires, a difference of potential may exist between the cap and one of the leads of the shooting cable, which may come in contact with a rail or pipe line that would explode the cap. All this may be due to poor bonding in an adjacent section of the mine. So from the safety point of view, as well as from better operating conditions, it is necessary to see that the bonding is well and carefully done.

As we have just started out in the new year, and have taken many precautions to prevent accidents happening in the future similar to those that happened in the past, let us from now on take safety precautions to prevent accidents that never have happened so that we may not have to profit by the experience deduced from a serious or fatal accident.

Legal Decisions on Mining Questions

Careless Inspection of Mine Roof. (Missouri) Though ordinarily it is a miner's duty to look after the safety of the roof of the room in which he is working, and the employer's duty to furnish props necessary for the roof where a foreman undertakes to make an inspection as to the safety or soundness of the roof, it is his duty to exercise ordinary care to ascertain the true condition of the roof and inform the miner of the facts. His making a careless inspection will render the company operating the mine liable for any injury which the miner may receive and which may be the result of such careless inspection.—*Hall vs. Manufacturers Coal and Coke Co. 168 S. W. 927.*

Taxation of a Mineral Interest. (Minnesota) Where mineral interests in real estate are owned separately from the interests in the surface, such mineral interests are land, taxable as such, and should be taxed separately from the surface interests.—*Washburn vs. Gregory Co., 147 N. W. 706.*

The Negligence of Mine Operator Questions for Jury.—(Wyoming) Plaintiff, a young man, without experience as a miner, was employed by defendant. After he and his coemploye had fired a shot to loosen coal, they discovered a large piece partially loosened, with a crack in the vein. Being unable to pry the coal down with a bar, they proceeded with their work, and the piece fell and injured plaintiff. Experienced miners testified that experience and instruction in the sounding test were necessary to enable a miner to determine whether coal such as this was in danger of falling. Held that, in view of plaintiff's testimony that he believed the place to be safe, he could not, as a matter of law, be held to have assumed the risk; and hence the questions whether defendant was negligent in failing to instruct him and such negligence caused the injury were for the jury.—*Carney Coal Co. vs. Benedict, 140 Pac. 1013.*

ANSWERS TO EXAMINATION QUESTIONS

Questions Selected From Those Asked at an Examination for Mine Foreman, Held in Price, Utah, September 15 and 16, 1914

QUES. 1.—In a seam of coal undermined by hand, what are the principal precautions you would insist on the miner taking?

ANS.—The roof near the face should be properly supported before undercutting is begun, and while the mining is being done the breast of coal should be supported by wooden sprags or by thin webs of coal so that it will not fall upon and crush the miner. Before the coal is shot down, the sprags or webs are removed.

QUES. 2.—The portal to one of our mines is a concrete arch, at which the air is measured. The arch is 10 feet high, 8 feet to the spring line, and 8 feet wide. What is the perimeter and area of this intake?

ANS.—The cross-section of this airway may be considered as made up of two separate parts; a lower square section 8 feet on each side, and an upper section in the form of a segment of a circle, the span of which is AC is the width of the portal or 8 feet and the rise $DB = 10-8=2$ feet.

The radius must first be calculated. In Fig. 1, since the width $AC = 8$ feet, then one-half the width $AB = 4$ feet. Let R = the radius; $OA = R$, and $OD = R$; and $OB = (R-2)$.

In the right triangle OAB, $\overline{OA}^2 = \overline{OB}^2 + \overline{AB}^2$, being the hypotenuse of a right triangle, or transposing, $R^2 = (R-2)^2 + 4^2 = R^2 - 4R + 4 + 16$.

R^2 cancel, then, $0 = -4R + 20$, or $4R = 20$, $R = 5$ feet.

Angle AOD = angle whose sine is $\frac{4}{5}$ or $.8000 = 53° 8'$.

Angle subtended by the entire arc is $AOC = 2 \times 53° 8' = 106° 16'$ or 106.267°. The perimeter and area may now be found.

(a) Perimeter. The length of the circular portion ADC may now be found:

$$l = 2\pi R \frac{106.267}{360} = \frac{31.416 \times 106.267}{360}$$

= 9.4 feet. The other three sides of the airway are each 8 feet long; hence the total perimeter is $9.4 + 3 \times 8 = 33.4$ feet.

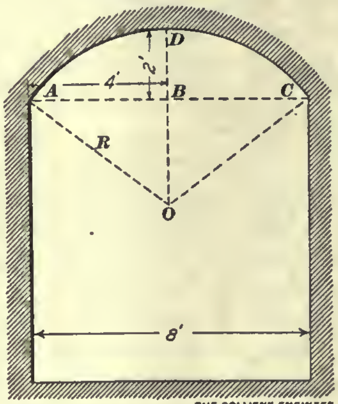


FIG. 1

(b) Area. The area of the upper portion may be found from $A = \frac{1}{2} lR - \frac{AC}{2}(R - DB) = \frac{1}{2}(9.4 \times 5) - \frac{8}{2}(5-2) = 23.5 - 12 = 11.5$ square feet. The lower part of the airway is a square 8 feet on the side and contains 64 square feet. The total area of the portal is, hence, $11.5 + 64 = 75.5$ square feet.

QUES 3.—What two conditions of the human mind are fruitful causes of accidents?

ANS.—Carelessness on the part of those who know and ignorance on the part of the uninformed, are probably responsible for the majority of coal mine accidents. It would seem that carelessness and reckless disobedience of orders are, however, the cause of more accidents than mere ignorance.

QUES. 4.—Explain how the pressure constant 5.2 pounds is arrived at.

ANS.—The weight of 1 cubic foot of water, that is, of a volume of water whose base is 1 square foot and whose height is 1 foot or 12 inches, is very nearly 62.4 pounds. From this, the weight of a volume of water whose base is 1 square foot, but whose height is 1 (not 12) inch, is $62.4 \div 12 = 5.2$ pounds. In other words, the constant 5.2 pounds, represents the pressure upon a square foot due to a column of water 1 inch high. The constant is of daily use in ventilation problems as each inch on the water gauge represents a pressure of 5.2 pounds per square foot in the airways and is a measure of the resistance of the mine to the circulation of the air.

QUES. 5.—Explain how it is that a prop (post) set vertical in an inclined seam will not carry as much weight as one set perpendicular to the floor.

ANS.—Props, to sustain the greatest weight, must be set so that the pressure comes upon them in the direction of their length. When the coal is removed from a seam and the roof, as a whole, falls, it does not fall vertically unless the bed is horizontal, but falls in a direction at right angles to the dip, that is, perpendicular to the floor. Hence, to best resist this pressure at right angles to the dip, the props must be set perpendicular to the floor. If they are set vertically in an inclined seam, the weight upon them tends to turn them over.

Ques. 6.—In opening a new mine, with the expectation of developing a large mine, what method would you adopt to make it sanitary, and take care of the offensive droppings of the men?

Ans.—If the mine is fairly wet and pumping machinery is employed, it is possible to provide water closets at convenient points, whence the deposits are conveyed by the water to a special sump and pumped thence to the surface. In dry mines this is not possible, and a room on each entry may be set aside for the purpose in which are the necessary number of galvanized iron cans provided with covers. These can be gathered up by a special driver and truck at the end of the day, taken to the surface, thoroughly cleaned and disinfected, and returned before the run begins next day. At the Anaconda mine, Butte, Mont., a special toilet car is driven through the workings two or three times daily, and the same plan might be adopted at coal mines although a place, always available, would seem better. The Anaconda car is described in Mines and Minerals (now The Colliery Engineer) on page 410, of the issue for February, 1910. Chloride of lime and similar disinfectants should be provided, and should be applied to the droppings as often as the cans are used and, further, should be freely sprinkled on the floor of the room in which the cans are placed.

Ques. 7.—If 13 cubic feet of air at ordinary temperature and pressure weigh 1 pound, how many tons of air pass through a mine in 8 hours, when the current measures 52,000 cubic feet per minute?

Ans.—In 8 hours there are $8 \times 60 = 480$ minutes. In 480 minutes there will pass through the mine $480 \times 52{,}000 = 24{,}960{,}000$ cubic feet of air. At 13 cubic feet to the pound, this will weigh $24{,}960{,}000 \div 13 = 1{,}920{,}000$ pounds. This weight is equivalent to $1{,}920{,}000 \div 2{,}000 = 960$ tons.

Ques. 8.—We have a large mine in a 16-foot seam of coal. The first six entries on one side of the mine are nearly worked out. These entries suddenly give off large quantities of blackdamp. It is impossible to carry off the CO_2 through the return, and all the workings are below the sixth entry. What course would you pursue?

Ans.—Even if a little coal is lost thereby, it might be the cheapest in the end to abandon the six entries where the gas is generated and seal their mouths along the main entry with air-tight concrete stoppings.

By driving a passage from the new workings into those generating gas and by reversing the direction of the air-currents, it might be possible to force the gas out either through what was originally the intake, or through a special drift or shaft driven to tap the gaseous workings. The most economical course would depend upon local conditions not stated.

Ques. 9.—State two causes that make it necessary to place timbers in a coal mine.

Ans.—The placing of timbers in its customary meaning refers to the use of timbers to resist the pressure and to prevent the falling of rock or coal; and the meaning is not modified by details in the method of their use. Thus timbers are placed singly as props in rooms, as framed sets in entries, as cribs to resist a squeeze, as shaft timbers, etc., and these are merely various ways of placing timber or timbering; and all are for the same purpose—to resist pressure.

Other reasons for using lumber underground are the necessity of building brattices, overcasts, etc., for directing the air-currents, and for ties upon which the track rails are laid.

Ques. 10.—Give the formulas relating to the ventilation of mines.

Ans.—It is impossible to give all the formulas used in working out problems in mine ventilation. The fundamental formula is $p = \frac{ksv^2}{a}$, in which p = pressure producing ventilation, in pounds per square foot; k = the coefficient of friction, commonly taken as .00000002; s = rubbing surface of the airway, in square feet, and is equal to the length multiplied by the perimeter; v = velocity of the air-current, in feet per minute; and a = area of airway in square feet.

Another commonly used formula is, $i = \frac{p}{5.2}$, in which i = height of the water gauge, in inches; and p has the meaning given before. Another formula is $q = av$, in which q = quantity of the air in circulation, in cubic feet per minute; and a and v have been defined. Still other formulas are u, qp, and $h = \frac{u}{33{,}000}$. In these, u = units of work or power on the air, in foot-pounds per minute; h = horsepower required to produce ventilation, the other terms having been defined.

With the aid of these five formulas all practical problems in mine ventilation may be solved.

Ques. 11.—In putting up crossbars, in which legs are used, why is it that the top of the legs are inclined toward the center, instead of being placed vertically?

Ans.—The legs are commonly given a slight pitch or batter to better enable them to withstand any pressure that comes upon them from the side or is thrown upon them in an inclined direction by reason of the roof settling unevenly upon the cap. The framing is stiffer and less liable to be shaken or forced out of place under uneven strains if the legs are given a slight batter. To resist the maximum crushing strength (which is not the only stress they have to resist) the legs should be set vertically.

Ques. 12.—What is the specific gravity of coal dust?

Ans.—The specific gravity of coal dust is the same as that of the solid coal from which it is derived. It will vary from about 1.20 for lignites to 1.50 for anthracite.

Ques. 13.—What causes the particles of coke on timbers which we find after an explosion?

Ans.—These small particles of coke are due to the coking of dust originally upon the timbers or of

that lodged upon them by the force of the explosion. They are also due to the coking of fine particles of dust in suspension in the air, which coked particles have united in masses of larger size and lodged upon the timbers. The coking of the dust is due to the rapid distillation of the volatile matter in the coal by the heat of the explosion. That the coal does not completely burn is due partly to the very rapid passage of the flame, but more particularly to there not being sufficient oxygen to allow complete combustion.

Ques. 14.—In arranging rules for your fire bosses, what four points of personal discipline would you require?

Ans.—The fire boss should be instructed to be punctual in attendance upon his duties; to be temperate, that he may be in condition to properly perform his duties; to be observing and faithful in making reports of dangers noted; and, while being just, to be strict in seeing that his commands are obeyed.

Ques. 15.—(*a*) In undercutting by mining machines, what are the main causes of accident? (*b*) How would you prevent these?

Ans.—(*a*) The chief causes of accident are the moving parts of the machine in which the runners may be caught; a fall of the breast of coal being undercut upon the helper who is shoveling back the slack; a fall of roof upon the runners; electric shock, and ignition of gas, if electricity is used.

(*b*) The moving parts, and particularly the chain, should be covered; the face should be held up by sprags placed at regular intervals as fast as the machine cuts out the coal; if the roof is weak, timbers which must be removed that the machine may cut past them, should before removal be replaced by others supporting the roof opposite that portion of the face which has already been undercut. If the seam is gaseous, electricity as a motive power may almost always be employed by using nothing but high class gas-proof motors kept in the best of condition, the air-current being kept up to the face by the necessary curtains or brattices. Low voltage currents, and carefully insulated cables and conductors, with good return connections should be used to eliminate the danger of shock.

Ques. 16.—State the volume, in cubic feet per pound, of each of the principal gases composing the atmospheric air.

Ans.—The principal atmospheric gases are oxygen, 1 pound of which has a volume of 11.21 cubic feet; nitrogen, 1 pound of which has a volume of 12.77 cubic feet; and a small amount of carbon dioxide, which has a volume of 8.15 cubic feet per pound. Air itself has a volume of 12.39 cubic feet per pound. These volumes are measured at a temperature of 32° F., and under a barometric pressure at sea level of 29.92 inches.

Ques. 17.—What will be the reading of the water gauge when the pressure per square foot is 20 pounds? Explain fully.

Ans.—For practical purposes a cubic foot of water may be taken to weigh 62.4 pounds. But a cubic foot has an area of base of 1 square foot and is 1 foot, or 12 inches, high. From this, a layer of water covering an area of 1 square foot and 1 inch deep has a weight of or exerts a pressure equivalent to $62.4 \div 12 = 5.2$ pounds. When an instrument known as a water gauge is used for measuring the pressure of the air in mine ventilation, a difference of 1 inch in the height of the water in its two legs, indicates a pressure of 5.2 pounds per square foot. The formula for expressing the pressure per square foot in terms of the height of the water gauge, in inches, is $i = \frac{p}{5.2}$, since each inch of water gauge is equal to a pressure of 5.2 pounds per square foot. In the present problem, if 20 pounds is p which is the pressure in pounds per square foot, the reading of the water gauge i will be,

$$i = \frac{20}{5.2} = 3.86 + \text{inches.}$$

Ques. 18.—If you were operating a mine in which firedamp was generated freely, and you were using locked safety lamps, the coal in the gaseous zone becoming exhausted and you decided to open up another part of the mine to keep up your output, in which no gas had ever been detected, what precautions would you take to prevent open lights being taken into the gassy zone?

Ans.—It may be assumed from the question that it is the intention of the management to permanently abandon the worked-out and gaseous part of the mine. In such a case it will be absolutely impossible for unauthorized persons to enter the gaseous workings if the connections between these workings and the main entry are permanently sealed with air-tight concrete stoppings. Whether the sealed-off workings should be ventilated with a separate split of air, or whether this should not be done, is a question about which authorities differ.

Ques. 19.—What are the dangers pertaining to a broken power wire, or a poorly insulated wire in a coal mine?

Ans.—In both cases there is danger of a shock and possible death to those who come in contact with the wire or with iron or steel objects which the wire or wires are touching. In the case of a broken power wire if an arc is formed, particularly when the voltage is high, there is great danger of a dust explosion. In the case of a poorly insulated wire the leakage of the current may lead to electrolysis of pipes and rails, or to fires if a short circuit results.

Ques. 20.—When should you send for a doctor, or take the injured person to a doctor?

Ans.—Whether "when" refers to the time the action should be taken or to the conditions under which it should be taken, prudence demands that the patient be turned over to a competent physician as soon after an accident as possible.

Ques. 21.—Before entering a mine, what observations and exam-

inations should be made by the mine foreman to satisfy himself of the general condition of the mine?

Ans.—He should examine the report of the fire boss for the places where gas and other dangerous conditions exist. This is the most important duty, as the fire boss has just left the mine and has the latest information on underground conditions. He should further see that the fan is running at its customary speed and drawing in the usual volume of air at the intake, and that the exhaust air gives no evidence of a mine fire. If the report of the fire boss is satisfactory and the fan is running properly, there is nothing else to be learned on the surface affecting the general conditions of the mine.

Ques. 22.—An entry dips 1½ per cent. and makes 500 gallons of water per minute at the face. The water is to be pumped from the face by a turbine pump having a capacity of 800 gallons per minute. The entry is to be mined. How would you arrange your work to have the least delay with water?

Ans.—The face should make a slight angle with the dip so that the left-hand corner is the lower and the water will gather there from whence it can be drawn with the suction pipe of the pump. The sumping cut can then be made on the right, and upon its completion the suction pipe can be shifted over from the left side and its end extended to the bottom of the cut. With some classes of mining machines the cut can be made at any desired elevation above the floor; when these are used, it is only necessary to keep one corner of the face where the suction pipe is placed a short distance beyond the other. In this case the coal is shot in two benches.

Ques. 23.—What is the greatest danger you expect to encounter in a dry, gaseous mine, when you find it necessary to change the air-current?

Ans.—The change in the air-current probably refers to a change in direction, that is, what is commonly called a reversal. If there are no men or fires in the mine at the time of reversal, there can be no danger from such action. If men are working with open lights at the time the current is reversed it is possible that the gas may be blown back upon some of them in sufficient quantity to cause an explosion which may or may not be violent enough to ignite the dust. It is difficult to imagine a state of affairs where it is necessary to reverse the air while the men are at work; also, there is no excuse for working a gaseous mine with open lights.

Ques. 24.—What weight of coal dust suspended in the air is necessary, according to experts, to cause an explosion by coming in contact with open lights?

Ans.—Experimental investigations by the Bureau of Mines showed that .032 ounce of coal dust suspended in each cubic foot of air, or 1 pound in 500 cubic feet of air could produce an explosion. Taffanel produced ignition with so low a weight as .023 ounce of coal dust per cubic foot. Tarnow found that the most violent explosions occurred when there was between .31 ounce and .5 ounce of dust to 1 cubic foot air.

Electric Cap Lamps as Life Savers

A gas explosion, causing the loss of 16 lives and the injury of 15 other men, occurred on October 5, at the mine of the Woodward Iron Co., at Mulga, Ala. A coincidence that prevented a greatly increased loss of life, was that Norris W. Campbell, a representative of the Hirsch Electric Mine Lamp Co., was at the mine, making a demonstration of the use of the Hirsch cap lamps on the day of the explosion.

At 7 o'clock in the morning he fitted out nine of the workmen with cap lamps, and the fortunate presence and use of these lamps is credited with the saving of at least eight and possibly more lives. One of the men, a negro named Harry Jackson, who was equipped with one of the lamps, is credited with having saved the mine foreman, Thomas Black, and with taking to safety nearly a dozen miners who were in imminent danger.

An unofficial statement as to the cause of the disaster, published in the Birmingham, Ala., *Age-Herald*, October 6, based on the statement of a miner, who was near the scene of the explosion, is as follows:

"The explosion was caused by a short-circuit of air due to a broken door. This short-circuiting caused an accumulation of gas, into which two foreign miners, disregarding a danger sign, entered with open lamps."

Two of the electric cap lamps were worn by men who were caught and injured by the explosion. They were brought out with both lamps still burning, and a bloody cap with one of the electric lamps attached and still burning was brought out with the injured.

In a signed statement, dated October 9, Ira C. Dalrymple, assistant general superintendent of the Woodward Iron Co., emphatically commends the utility of the lamps, and states that their fortunate presence and use enabled the rescuers to speedily penetrate all portions of the disturbed area of the mine. That during the excitement the lamps were subjected to very severe tests, were in constant use for periods as long as 16 hours, and they were safely used in penetrating passages filled with explosive gas. That during the 60 hours of rescue and repair work, the lamps were constantly used, and the only one that gave any trouble was tampered with by the user trying to examine the inner workings of the reflector.

In appreciation of the work of the negro workman, Harry Jackson, Mr. Dalrymple says: "He was working in an entry, inby the entry where the explosion occurred, and he removed all the injured men. He then went to the scene of the explosion and removed four more men who could not have lived many more minutes. He was also able to remove the mine foreman from the danger zone during the removal of the injured."

PERSONALS

J. M. Page, superintendent of Rex No. 2 mine of the La Follette Coal, Iron and Railroad Co., has resigned and been succeeded by George Walters, superintendent of the Gem mine.

Alfred Copeland Callen has been appointed instructor in the Mining Engineering Department of the University of Illinois. He graduated from Lehigh University in 1909 with the degree of Engineer of Mines, and received the degree of Master of Science in Geology in 1911; is a member of the honorary society of Tau Beta Pi; was instructor in Physics at Lehigh University 1909-10, and was instructor in Mining Engineering at the same institution 1910-11; since 1911, he has been assistant manager and draftsman of the Pottstown Machine Co., of Pottstown, Pa.

J. A. Richards has been appointed District Mine Inspector for the Calgary district in Alberta with an office at Calgary.

George P. Schubert has been appointed assistant professor of Civil and Mining Engineering at the Michigan College of Mines.

W. L. Carter, formerly general manager for the Bessemer Coal, Iron and Land Co., of Birmingham, Ala., is now general manager of the Himyar Coal Corporation, at Himyar, Ky., succeeding J. B. Allen.

The Central Coal and Coke Co. with headquarters at Kansas City, Mo., announces that Harry N. Taylor, of Chicago, has been made vice-president of the company.

R. Y. Muir, state mine inspector of the Eighth district of West Virginia, resigned his position and was succeeded, October 1, by John L. Absolem, of Montgomery, W. Va. The New River and Pocahontas Consolidated Coal Co. has announced the appointment of Mr. Muir as an inspector with headquarters at Berwin.

Walter B. Snow announces the removal of his offices to Rooms 511-516, 136 Federal Street, Boston, Mass. There his organization will be better equipped to act as publicity and general advertising agents.

Frank P. Weiser, division engineer for the Philadelphia & Reading Coal and Iron Co., in the Ashland district, has tendered his resignation and will live retired. Mr. Weiser served in that capacity for the company for 25 years. He has been succeeded by William A. Seitzinger.

Because T. A. Rickard, editor of *The Mining Magazine*, was aged out of the British Army, he sent his automobile and driver to the front. He is now more of an esteemed contemporary than ever.

John W. Boileau, one of the best known coal mining geologists in Pittsburg, Pa., committed suicide on October 7, by shooting himself through the head. It is considered by many that Mr. Boileau's principal achievement was his movement 3 years ago to secure coal and coke freight rate reductions between the Pittsburg district and ports on the Great Lakes. He instituted proceedings before the Interstate Commerce Commission in conjunction with the Pittsburg Coal Co. and other interests. The result was a reduction of 10 cents a ton, offsetting advantages previously held by West Virginia shippers.

A number of changes in the executive department of the D., L. & W. collieries have been announced by General Manager R. A. Phillips. The men affected by the change are all valued employes of the company, and the transfers are considered in the light of advancement for efficient service. M. C. Casey, outside superintendent at the Storrs mine, is retired under the rules of the company governing long service, an adequate pension being provided. G. W. Sampson, superintendent at the Bellevue mine, takes Mr. Casey's place at the Storrs; F. A. Sampson becomes superintendent of the Bellevue colliery, going there from the Hallstead mine. Assistant Superintendent James Doyle, at the Pyne colliery, assumes charge of the Hallstead workings. Anthony L. Mayer and Robert H. Carson, assistant foremen at the National colliery, the former for 8 years and the latter for 3 years, have been promoted to foremen at the same colliery where they will have full charge. John B. Owens, who has been foreman at the National colliery for several years and with his assistants achieved the record of having the smallest number of accidents of any mine in the district for a period of 3 years, has been transferred to the Dodge mine to succeed James B. Lewis, who goes to the Bellevue shaft. David Beynon, assistant foreman at the Dodge, is transferred to a similar position at the Taylor mine, and Thomas Davis, assistant at Taylor, is transferred to the Dodge as assistant foreman.

Truman M. Dodson, of the C. M. Dodson Coal Co., anthracite coal operators, has been appointed superintendent of the Beaver Meadow and Morea mines of that company, vice John Furnbach, resigned.

Hints on Coal Mine Ventilation

Department of the Interior Bureau of Mines has issued Miners Circular No. 16, entitled "Hints on Coal Mine Ventilation," by J. J. Rutledge. Every mine foreman and miner should write for this practical paper, as it contains some things they ought to know, and if they do them they will have a chance to learn what an expert has to say on the subject. It costs a postal card to obtain this valuable paper of 22 pages.

The great advantages of the steam turbine-driven centrifugal pump are small first cost, and low cost of upkeep, together with the fact that only very light foundations and small building spaces are required. These advantages outweigh considerably the somewhat lower duty obtained as compared with the triple expansion pump.

NEW MINING MACHINERY

A New Rotary Air Compressor

The Wernicke-Hatcher Pump Co. are marketing a rotary air compressor which looks as if a new departure was about to be made in the matter of air compressors, since this, unlike the Connersville and gas house blowers, is able to compress air to a stage where it may be used for power.

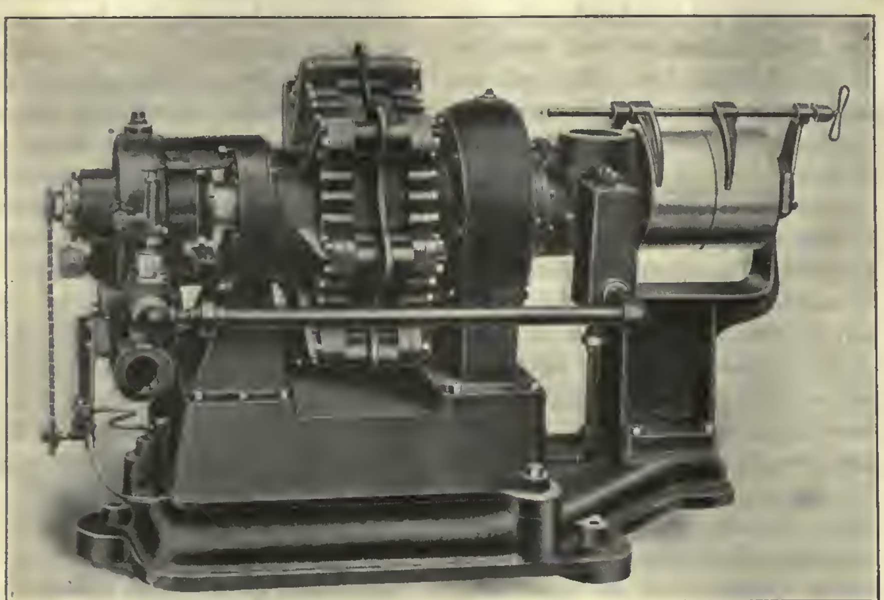


Fig. 1. New Rotary Air Compressor

Fig. 2 shows both the rotor and rotor case and the four pockets, each provided with an intake and discharge valve which connect with the intake and discharge passages in the hollow rotor shaft.

Both the rotor and the rotor case revolve, one within the other, in the same direction and at the same velocity. Each revolves, however, on its own axis in balance, and not as an eccentric. The compressor has in reality eight pockets, but Fig. 2 shows the principle more clearly. It shows the pocket *A* fully contracted and has just discharged its volume of air. *B* is expanding and sucking in air, *C* is filled with air, and *D* is compressing.

By this rotary scheme the heat of compression is practically eliminated at its source by radiation. All heavy moving parts are balanced and rotate at uniform speed, and during compression the pressure in the leading pocket is always greater than in the one following, thus pressing the vane against the wall of the slot, preventing back leakage and permitting effective sealing. The compressor is smooth running, has low power consumption, and is light and portable. It can be directly connected to an electric motor or belt driven, and is designed for pressures up to 100 pounds.

The eight compressing pockets in the actual machine make 3,200 compressions per minute at 400 revolutions per minute, which causes a steady flow and even torque. The compressor shown weighs 1,400 pounds without subbase, is 46 inches long, 28 inches wide, and 35 inches high, and has an approximate capacity of 75 cubic feet per minute (actual delivery not displacement) when operating at 100 pounds gauge pressure. Under continuous operation at the above speed and pressure the discharge temperature is only 275° F. based on 60° F. intake temperature.

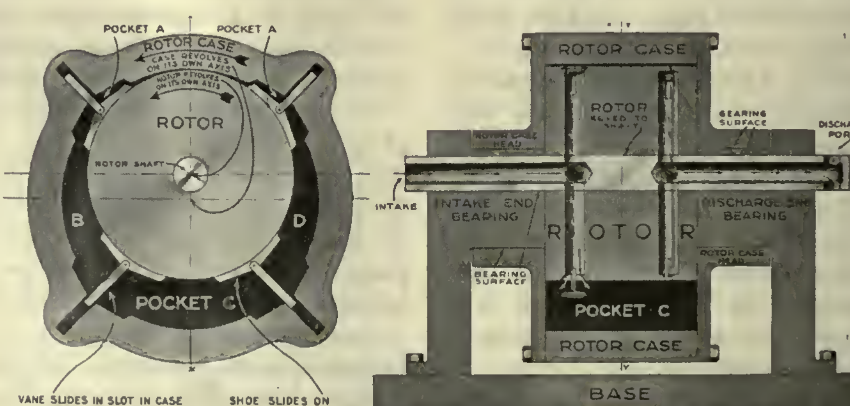


Fig. 2. Sections Through Compressor

White Star "Y" Blow-Off Valve

Of all the various steam valves none are subjected to such severe demands as the blow-off valve.

Valves heretofore designed for this purpose have invariably leaked badly after a few months' usage. The William Powell Co., of Cincinnati, after a thorough study have remedied the defects in other styles, and produced a valve known as the Powell "Y" blow-off valve.

In Fig. 3 *B* is the body or shell and *A* the yoke top secured by studs.

The packing is secured and regulated by the gland P, which is operated by the nut C above the yoke. This construction enables the engineer to adjust the pressure with a monkeywrench, a feature which will be appreciated by engineers. The plunger D is milled to receive the collar on the stem T. Spiral grooves cast on the outer face of D receive the steam pressure as the valve is opened and cause it to revolve as it nears the seat when closing, thus keeping both disk and seat clean. The seat ring F is low to prevent the rushing steam cutting it as the valve is opened. The disk E and seat bearing are constructed at an angle to prevent sediment or scale lodging between them, either while blowing off or closing down the disk.

To regrind this valve, insert a wire through the hole R in the plunger, to lock the disk, and then rotate back and forth with a little fine brick dust or sand on the bearing. The seat ring F made of Powellium white steam bronze, has two faces. When one is worn, it is removed and reversible. The disk E is not only regrinding and reversible but it is also renewable. It is cast of "Powellium," a white bronze, which, in point of service and durability, will outlast other disk metals and is guaranteed to stand 2,000 degrees of heat. The valves made in 2-inch and 2½-inch size with screw or flanged ends, are tested to 250 pounds hydraulic pressure, and guaranteed for severe service.

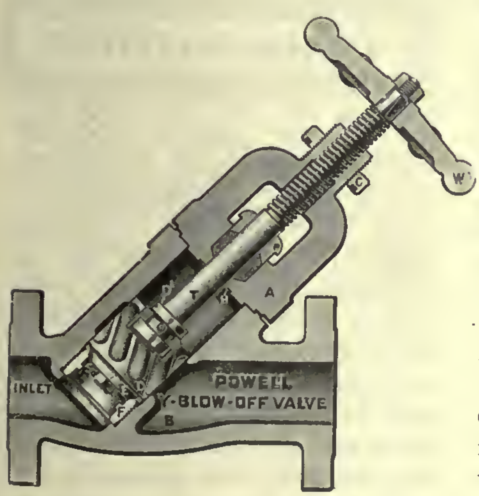


FIG. 3. "Y" BLOW-OFF VALVE

Bates Rail Clamp

The essential features of a successful rail clamp may be summed up as simplicity in construction, ease in manipulation, and strength. These features have been combined in the Bates rail clamp, as shown in Fig. 4. The clamp was invented by W. H. Bates, superintendent of the steam shovel repairs on the Panama Canal, and his patent was subsequently acquired by the Bucyrus company, South Milwaukee.

The simplicity of its construction is strong in its favor, and no doubt it will be found serviceable in many instances at coal mines and coke works to prevent cars running out of the yard onto the main track. The present system of an open switch, results in derailing a car and in considerable trouble before it is shoved back on the track. The clamp should, therefore, prevent the car running out on the main line, and if it does not succeed in stopping the first wheels on the truck, it would succeed in stopping the second, and that, too, without derailing the car.

The clamp consists of two steel castings hinged by a heavy pin, and it works like ice tongs. For convenience in movement it has a handle in one of the cast pieces. A steel wedge is driven in between the handle and the top of the rail. This makes it easy to put on and take off. The old way of fastening clamps to the rail is by driving a wedge beneath the base as shown in the illustration. Also on the Bates clamp it will be noted that no excavation is required in order to place the clamp, as was necessary with the old style of clamp. This makes it easier to put in place, while it is fully as effective.

The clamp is made in three sizes. For 90-pound and 100-pound rails, it weighs 40 pounds; for 70-pound and 80-pound rails, it weighs approximately the same; for 50-pound and 60-pound rails, it weighs 37 pounds. These sizes can be handled by one man readily.

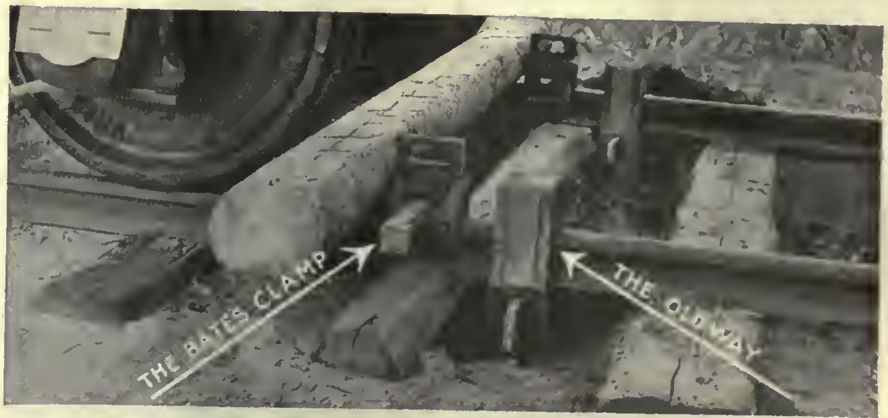


FIG. 4. RAIL CLAMPS

The New Pyro-Perolin Process

The complete removal of scale and the successful maintenance of clean boilers has long been a knotty problem for steam engineers. A method much used in European countries, especially in England and Germany, and known as the Pyro-Perolin process, cleans boilers from incrusting scale quickly and thoroughly.

The cleaning requires from 1 to 3 days' time, according to the size of the boiler and its condition. Briefly, the system consists of an apparatus which generates and combines gases in such proportions that when they are ignited and the flame applied to the scale which has been previously treated with Perolin, the scale completely disintegrates and decomposes, leaving the metal bare. A liquid protective, heat-conducting film is then applied and as long as this film is maintained, incrustation

of scale is impossible. The boilers are cleaned by this process and the protective film applied and maintained at a definite cost, guaranteed in a contract and bound by a surety bond.

New Breaker Engine

The Kingston Coal Co. has installed at their No. 4 colliery a cross-compound Hugo Lentz engine, the first one of the kind to be used in the anthracite regions of Pennsylvania. Although the first engine was built in 1899, at the present time 4,000,000 horsepower of these machines have been installed in Germany, a most difficult country to introduce anything new in the steam engine line unless it has superior economical features. The Kingston Coal Co.'s engine has so little vibration that E. L. Solomon, master mechanic, stood a nickel on its edge, on the cylinder, where it remained without toppling over. The principal features of this engine are as follows: Diameter of the high-pressure cylinder, 19½ inches; diameter of the low-pressure cylinder, 32½ inches; stroke, 21 inches; no elastic or metallic packing is used; the valves are of the double-seated poppet kind and as there is no rubbing surface, no lubrication is required; a horizontal shaft connected by bevel gears to the engine shaft drives the valves, which are designed to stand the temperature of saturated as well as superheated steam, as they are actuated by a cam working on a roller.

When the valve is seated the cam is disengaged, but the cam and roller are always in contact until the valve is seated, consequently there is no noise, nor any limit to the number of revolutions at which the valve gear may be speeded.

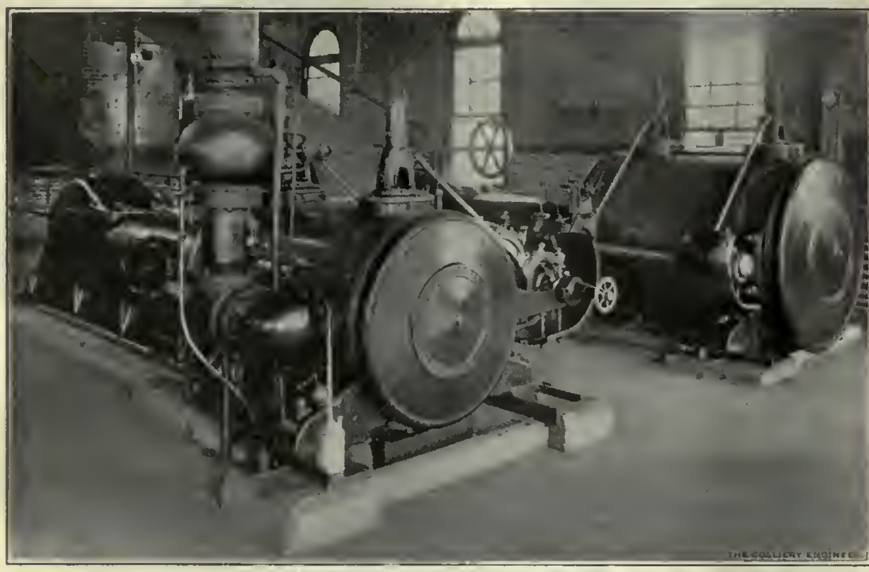


Fig. 5. Lentz Engine, Kingston Coal Co.

The inertia weight governor is quick and sensitive in action, transferring its travel directly to the steam eccentrics without intermediate connection. The lubrication is performed by the splash system, the crank being cased and run in oil, thus insuring ample lubrication at all times. In the matter of steam economy, the Lentz engine is stated to be superior to the Corliss or any other kind of steam engine so far devised.

The Simplex Surface Contact System

The newest thing in electric haulage is the Simplex system.

The first principle of the Simplex system lies in its safety. The transmission wires are placed underground and enclosed in a conduit.

The manner of supplying current to the moving locomotive from the conduited cable is by means of a switching device or contact box. The contact box is made of heavy reinforced insulating material capped with a heavy metallic lid. The box is bolted to the ties in the center of the track close enough together that one will always be under the locomotive. Suspended under the locomotive is the shoe, similar to those used on third rails save that in this case it is long enough to reach from one box to the other, always permitting contact. This shoe conveys the current from the tops of the boxes to the motors of the locomotive in an uninterrupted flow.

The boxes each contain a magnetic switch that is operated by a magnetic device carried on each locomotive so the only box in a live condition is that one directly under the locomotive. As the latter passes off the contact, the switch within the box is rendered lifeless and inanimate. The whole device is dust-, water-, and fool-proof. The tracks can be laid anywhere with perfect safety and unlike the overhead trolley or a third rail, the electric current can be cut off beneath the locomotive at any point along the line, at any time that is desired, permitting locomotive repairs, etc.

TRADE NOTICES

The Wasson Coal Co. is rapidly becoming a big factor in coal production in the Illinois-Indiana district. At present they are opening new mines at Harrisburg, Ill., and Vincennes, Ind. These mines are of modern construction with full electrical equipment. Coal will be cut with chain machines. Electric locomotives used for haulage and gathering and electrically driven hoisting, pumping, and ventilating machinery will be used throughout the mine. Orders for 21 locomotives have been placed with the Morgan-Gardner Electric Co. This is one of the largest orders for mine locomotives ever placed in Illinois.

The recent award by the city of Philadelphia for two 20-million

gallons per day, steam turbine-driven, geared centrifugal pumps, operating against a total head of 330 feet, signalizes the radical change now taking place in water-works equipment. These pumps are to be built by the De Laval Steam Turbine Co., of Trenton, N. J., who made a duty guarantee upon same of 145-million foot-pounds per 1,000 pounds of steam.

Roberts and Schaefer Co., of Chicago, announce that after October 15 their Pittsburg representative, Mr. Willis E. Holloway, will have headquarters at the home office, McCormick Building, Chicago, Ill.

The Gun-crete Co. has acquired all the interests, titles, contracts, and rights of the Cement-Gun Construction Co., and has also absorbed the construction department of the General Cement-Gun Co., and the combined business will be conducted under the firm name of Cement Gun Construction Co., with main office at 914 South Michigan Avenue. In future they will do cement-gun construction work of all kinds, and sell and lease complete cement-gun equipments.

Catalogs Received

Draeger Oxygen Apparatus Co., 422 First Avenue, Pittsburg, Pa. Circular Letter from Mr. Bernhard Draeger in Germany.

Ohio Brass Co., Mansfield, Ohio. Circular, "A Study in Contrasts."

National Tube Co., Frick Building, Pittsburg. Bulletin 9C. Some Tests of "Kewanee" Unions, 7 pages.

Electrical Engineers Equipment Co., 711-715 Meridian Street, Chicago, Ill. Bulletin No. 101, Disconnecting Switches, 16 pages; Bulletin No. 102, Cable End Bells, 24 pages.

Burd High Compression Ring Co., Rockford, Ill. "A Few Facts About Piston Rings, Their Relation and Importance," 8 pages.

Wm. Powell Co., Cincinnati, Ohio. Powell Steam Whistles and Whistle Valves, 14 pages.

Ingersoll-Rand Co., 11 Broadway, N. Y. "Little David" Pneumatic Drills, 35 pages; "Little Tugger" Hoist, 8 pages; "Little David" Pneumatic Chipping, Calking, and Scaling Hammers, 12 pages.

Western Electric Co., 463 West Street, New York, N. Y. Circular describing various household and other devices made by the Western Electric Co.; Western Electric Poles, 12 pages.

Jos. Dixon Crucible Co., Jersey City, N. J. Circular describing the Atlantic City steel-fence paint tests.

Mine Sanitation Section

The United States Bureau of Mines is to investigate the conditions under which miners work, the Director believing that the unsanitary conditions existing in some of the mines as well as mining towns are factors in the death rate among the men. It is intimated that these conditions not only cause the death of miners through disease, but are often responsible for accidents which might not have happened had the miners been in perfect health.

The bureau has organized what is known as the Mine Sanitation Section, in charge of J. H. White, engineer.

The bureau hopes to progress by appealing to the miner, the manager, and the owner, showing that all three can assist, and be benefited by good sanitary conditions. Illustrated lectures, moving pictures, and pictorial circulars, will show how sickness and suffering are spread by careless habits, and the importance of personal and household cleanliness. The bureau will point out to the managers glaring sanitary menaces, and show methods and costs of abatement. It will describe in bulletins unsanitary practices and show the evils which follow in their wake. It will submit sanitary rules and regulations and show the best methods for their enforcement.

Engineer White, in talking about mining towns, said: "The mining town does not grow but is built at a single stroke. The effect of this is that the valuable lessons learned by the 'try-out' method and the profit gained by previous mistakes do not exert their powerful influence, so that the errors existing in one house exist in all. Of course, one could have learned from the experience of other mining towns already built, but this information was perhaps not readily available and local conditions modify each case.

"The company ownership is the most important factor entering into housing conditions. Every house reflects the standard which the operator wishes to maintain. It is difficult to stimulate personal pride among the inhabitants if friendly rivalry is absent. However, where improvements are introduced they are far reaching and the tone of the entire town is raised.

"The necessity and importance of a satisfactory water supply for the people who were to get out the coal was probably not given much consideration in the past by the ignorant, and in studying conditions with a view of introducing a public water supply into a town the cost of improvements and the age of the town must be carefully balanced.

"The inconveniences due to drawing water from wells may be eliminated by establishing bath houses at the mine shaft where men may wash upon coming out of the mine. A public laundry is a great convenience for the women; lugging in several tubs of water, preliminary to doing a week's washing is a severe burden. Bath houses in or near the schools, for the women and children, are almost necessary accessories to the perfect system. Wholesome safe drinking water is essential to existence; its supply is one of the gravest responsibilities accompanying company ownership.

"There are few mining towns with sanitary sewer systems. Such a system presupposes a public water supply for flushing purposes. The approximate location of a mining town is determined by the mine shaft and the topography must be accepted as it is. This is generally

rough and hilly, and a single gravity system of sewers is next to impossible as the cost of leveling off the hills and grading the streets is prohibitive Moreover, a suitable stream to take the discharge of the sewers might not be near at hand; and the necessity of installing a sewage disposal plant looms up.

"Mining towns possess many advantages, but the drawback lies in the fact that the initiative in maintaining sanitary and clean conditions throughout the mining town rests entirely with the operator. Indifference on his part may give rise to deplorable unsanitary conditions. The residents have no official voice in the government of the town, and unofficial aggressiveness is seldom exerted because the total absence of property rights breeds irresponsibility and carelessness. Many of them are blissfully ignorant of the dangers of unsanitary surroundings, and when they protest it is the inconveniences rather than the dangers that bestir them."

A Signal-Bell Explosion

At the Bedwas colliery, in Monmouthshire, an unusual explosion of firedamp took place March 27, 1913, as reported in the Annual Report of the Department of Mines. Twelve men were burned, three of them subsequently dying from the effects.

The mine was new, the development work being in the Black vein at a depth of almost 2,400 feet and the workings of limited extent. The east level on which the explosion occurred was driven for a distance of 420 feet from the North Pit, which was the upcast shaft. Save for a small fan at the bottom of the shaft, the ventilation was natural. At the time of the explosion, however, the fan was directed in another heading. The inner portion of the east level for a distance of 200 feet was ventilated by compressed air, transmitted through 1-inch pipes.

A small haulage engine, also worked by compressed air conveyed in a separate range of pipes, was fixed by the side of the roadway, at a distance of 160 feet from the face as shown in Fig. 1.

About 7:15 A. M. four shots for blowing down the roof had been fired on the east level, about 45 feet outby of the haulage engine, and both ranges of air pipes were

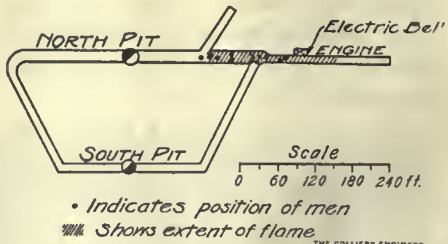


Fig. 1.

broken by the rock blown down. This disabled the haulage engine, and destroyed the ventilation of the inner portion of the level.

The men working at the face of the level were withdrawn, and set on to clear away the stone blown down by the shots, in order that the air pipes might be repaired.

The lights in use were exclusively double-gauze, bonneted safety lamps, which were all found to be in good order when examined after the explosion.

While the work of repairing the pipes was in progress, firedamp accumulated at the face of the level, and gradually worked back to the engine.

Immediately after an electric signal bell at the engine was heard to ring, the explosion occurred, and one of the injured men said he was looking toward the bell at the moment and saw a flash of flame, after which he was burned and could remember no more. The ringing of the bell was not intentional, and was probably caused by the signaling wires being accidentally brought into contact with each other by men who were preparing places for doors further out on the level.

The men who were burned were all on the east level. No great force was developed by the explosion, but indications of flame could be traced for about a distance of 210 feet along the roadway 60 feet inby and 50 feet outby, from the electric bell. The level was rather damp and practically free from coal dust.

The electric bell, of trembler type, was worked by an induction coil and a battery of eight Leclanche cells placed near the bell. The battery produced current at 11½ volts pressure when tested after the accident. It was afterwards proved, experimentally, that sparks from this bell, when rung by a current at 11½ volts, would ignite an explosive mixture of illuminating gas and air; and the mixture was also fired by sparks from signaling wires, produced by a current of only 4 volts pressure.

The District Mine Inspector declared this explosion to be the first recorded case of a colliery explosion caused by sparks from signaling apparatus; and it is curious that another non-fatal explosion, due to the same cause, occurred at another colliery later in the year.

Playgrounds for School Children

The playgrounds committee of the Nanticoke, Pa., town council reported that the Delaware, Lackawanna & Western, and the Susquehanna coal companies were ready to execute papers with council, donating land for the playgrounds and that the companies had been generous. At No. 2 shaft of the Susquehanna company, Superintendent Kohlbraker had granted more land than had been asked for. The second playground on this company's land will be near the old power house, while the playgrounds on D., L. & W. land will be on Lincoln field and near Concrete City.

The Supreme Court of Pennsylvania has decided that the amount of damage collectible on growing timber set on fire through negligence is not only the value of the wood destroyed, but also the injury to the property as a whole through the destruction of the young growth.

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The Colliery Engineer
Formerly
Mines and Minerals

Vol. XXXV—No. 5 DECEMBER, 1914 Scranton, Pa.

The Briquetting Plant

Of the Pacific Coast Coal Co., at Briquetville near Renton, Washington—First Commercial Use of Asphalt for Binder

*By Clancy M. Lewis, S. B.**

THE Pacific Coast Coal Co., has been operating bituminous coal mines for a number of years at Black Diamond, Franklin, Burnett, and Newcastle, Washington. These mines are comparatively short distances southeast of Seattle, and are on branches of the Columbia & Puget Sound Railroad. The Black Diamond and Newcastle branches of this railroad converge at Renton, on the southern shore of Lake Washington, where coal bunkers have been located for several years and where the company owned land for further development of its business and for storage purposes.

The principal problem before the company was to create a demand for the screenings resulting from the mining and handling of its coals. The coal which crumbles easiest in these mines is reported to come from the purest portion of the beds.

For some time it has been the thought of the Pacific Coast Coal Co.'s managers that the most advantageous way to market its coals would be to briquet them, and the late James Andersen, chief engineer, was commissioned to investigate the several operating plants in the United States, and his report led to the employment of the Malcomson Briquet Engineering Co., Chicago, to design, erect, and turn over in working order a briquetting plant of given capacity.

The original specifications called for coal burning furnaces and the use of coal tar as a binder, but experimental results with asphalt led to its adoption, and that of oil-burning furnaces.

The site selected for the plant occupies for the most part a side hill west of and below the main line of the Columbia & Puget Sound Railroad, between Renton and Newcastle, and is immediately east of the Lake Washington branch of the same road. The plant is provided with a special briquet loading spur track which is also direct-connected with the Northern Pacific, a quarter mile distant.

The plant is thus provided with two lines of railroad, and water transportation as well, by way of the Lake Washington canal to Puget Sound and the Pacific ocean.

The plant includes ten buildings and three tanks. The buildings are: Raw coal bin, 32 ft.×42 ft.; dryer building, 36 ft.×105 ft.; press building, 32 ft.×64 ft.; transformer station, 12 ft.×24 ft.; boiler and kettle house, 36 ft.×42 ft.; laboratory and office, 18 ft.×28 ft.; briquet storage bin, 20 ft.×32 ft.; demonstrating station, 12 ft.×20 ft.; watchman's cottage, 22 ft.×28 ft.; and pump house. Most of these buildings are shown in Figs. 1 and 2.

In Fig. 2 is shown a wooden water tank of 10,000 gallons capacity. Water is pumped 1,250 feet from Lake Washington to this tank by a motor-driven centrifugal pump, which has a capacity of 500 gallons per minute, and is controlled in the press building

FIG. 1. BRIQUETTING PLANT, BRIQUETVILLE, WASH.

FIG. 2. ANOTHER VIEW OF BRIQUETTING PLANT

* Mining Engineer, Beaux Arts, Washington.

by an electric switch. At this receiving tank, there is a steam pump which, working under high pressure, supplies water to all the pipe lines and to the 50,000-gallon storage tank 95 feet above the press building foundation.

There is also a steel tank for oil about 55 feet above the boiler house which will hold 600 barrels. The two latter tanks are not shown.

The coal bin, shown to the left in Fig. 1, is constructed entirely of fir timbers bolted together. It stands 80 feet high overall and contains two coal compartments of 400 tons capacity each.

The transformer, boiler, and kettle buildings have structural steel frames covered with corrugated galvanized iron sides and roofs; the dryer and press buildings are sided with galvanized iron and roofed with asbestos covered corrugated iron.

The demonstrating station, briquet storage bins, laboratory and office, cottage, and pump house are wooden structures.

The coal coming from the Black Diamond, Newcastle, and South Prairie mines in hopper-bottom coal cars is discharged into an iron-lined concrete hopper. A Link-Belt reciprocating feeder receives the coal from the hopper and delivers it into the buckets of a gravity discharge elevator of 100 tons capacity per hour.

From the elevator the coal is carried by a conveyer into the coal bin.

Regulation of the quantity of the coal used in the manufacture of a briquet begins when the coal is drawn from the storage bin. To regulate the amount of coal to be used in the briquet, to control the proportions, and to insure a uniform mix and a constant quantity, positive mechanical plunger feeders force the discharge from each of the compartments of the coal storage bin on to its respective horizontal flight conveyer.

A motor-driven shaft with chain-belt and sprocket connections operates the feeders. Eccentrics control the stroke of the plunger and the sprockets regulate the speed. Each feeder is designed for a capacity of 50 tons per hour.

Flight conveyers, in steel casings, deliver the coal either to a Williams pulverizer, or to one or both of the two dryers.

The system at this point in the plant provides, by means of elevators and conveyers, for putting the coal through the dryers and crusher in any order desired, or required, to put the material into the proper condition for mixing and fluxing.

The dryers, shown in Fig. 3, are 9 feet in diameter and 65 feet long. Heat is supplied to the dryers by the combustion of oil in the equipment, shown attached to the dryers. This illustration shows the receiving end of the dryers with platforms giving access to the regulation of the burners, the system of mounting the furnaces and burners, one of the two dryer fans with silent-chain drive direct from the motor, and in the upper right-hand corner may be seen the casing that encloses the flight conveyers and controls the dust.

The dryers, by means of transverse screw conveyers, discharge into either boot of bucket elevators, one of which returns the dry coal to the Williams pulverizer, and the other one lifts it to the regulating bin just in front and above the mixing conveyer.

The dryers supported on rollers are driven by gears near the center connected to motors.

The dryers revolve eight times each minute and the work of reducing the moisture in the coal to $\frac{1}{2}$ of 1 per cent. is assisted by the 4-foot dryer fans, driven by 15-horsepower motors, which direct the flow of heat through the dryers, and at the same time draw moisture-laden air from them and exhaust it through the cyclone dust collectors which are to the right of the coal storage bin and immediately over the end of the dryer building.

A General Electric centrifugal compressor running at 3,600 revolutions per minute supplies low pressure air for the oil burners. The compressor is directly driven by a 10-horsepower motor.

After the coal has been pulverized to sufficient fineness and all the dust returned to it from an elaborate system of collectors, and is in a state of almost absolute dryness, it is delivered by bucket elevators to the regulating bin. It is necessary that the moisture be reduced to a negligible quantity that the mixing may be thorough and the fluxing uniform.

On the discharge platform of the regulating bin an employe called the "mixer," receives instructions, as to the quantity of coal and binder to introduce, from the pressman by means of bell signals. The mixer, by gate control, regulates the amount of coal carried by an apron conveyer to the mixing conveyer, and, by a steam-jacketed valve, the flow of asphalt binder which is introduced just after the coal enters the mixing conveyer.

This mixing conveyer is a horizontal steel shell with a rectangular cross-section and reaches from the discharge of the apron conveyer of the regulating bin 30 feet to the feeder at the fluxer. Within the shell are mounted, longitudinally, two shafts upon which are paddles that mix the coal and binder and at the same time work it forward to the fluxer.

From the paddle mixer the coal and binder are discharged into a feeder which supplies the fluxer where the final and most important stage in the process of preparation takes place. In this fluxer the binding qualities of the mix are perfected, and the future physical properties of the briquet are created.

The fluxer consists of three superimposed horizontal cylinders in a single casting. Within each cylinder there is mounted a shaft, and upon the shaft are set arms, or paddles, which agitate the mix while superheated steam is being introduced through double horizontal rows of tuyeres on each side of the cylinder. The function of this steam is to maintain the asphalt in sufficiently fluid condition to permit of its being intimately mixed with the coal by the beating action of the fluxer paddles.

From the fluxer the material passes through two Schorr screw conveyers to the feed-box of the press. It is necessary, where asphalt is used for

binder, to cool the fluxed material before it enters the press, and this is done by an air-exhaust system attached to the conveyers and also to the press feed-box.

Essentially the Rutledge briquetting press here used consists of three parts—two major shafts with punch ram attachments and an endless bed with die-plate sections. The three

Attached to the upper group of rams are twelve arms, or pilot punches, one corresponding to each ram, which engage the corresponding die plates and time them for the punches. It is the pilot punches which furnish the motive power for die-plate bed. So nicely is the work of the press timed that only $\frac{1}{64}$ of an inch is allowed for clearance. Turn-

all bushings are of bronze alloy made to withstand high pressures. In the lubricating system the oil is driven through the main shafts to the interior of the press and from there works its way to the surface, properly lubricating all parts and preventing the entrance of any dust or grit. The press and its installation cost about $50,000.

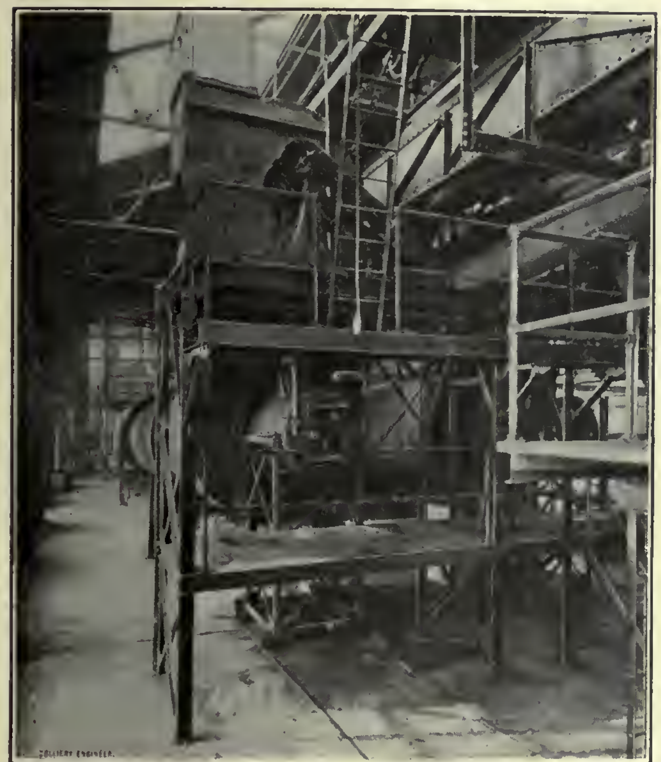


Fig. 3. Dryers

Fig. 4. Cooling Conveyor

are synchronized by proper gear connections and in turn driven by a 75-horsepower motor connected by friction clutch and silent chain drive. These connections and parts are shown in Fig. 5.

Each shaft is mounted with 12 punch rams and each ram has 14 punches, which are the short cylindrical projections shown between the main legs of the press above the dies. The rams are so hung that they assume an exact vertical position before they engage the die plates which are shown in the press with the round holes. A vertical pressure is exerted upon the material within the die plates from both above and below. Each pulsation of the press produces 200 tons pressure, or about 30,000 pounds upon each briquet.

ing over at the rate of 10 revolutions per minute the press produces 30 tons per hour, or 1,000,000 briquets per day.

Press punches are constructed with removable tips, which not only provides for quick adjustment and economical maintenance of the parts receiving the greatest wear, but also for the change of the brand, or trade mark which is impressed upon every briquet. This brand designates the coal used and serves as a guarantee to the consumer that he is getting the quality for which he paying. These tips are made from forged and hardened nickel steel.

The press weighs 80,000 pounds. The rollers are of nickel steel, the tracks of manganese steel, the cams and springs of vanadium steel, while

As the briquets leave the press they slide down over a perforated apron to the cooling belt, or conveyer, shown in Fig. 4, loaded with briquets. This belt is over 600 feet long and is composed of 47,000 flat links giving a large area for the free circulation of air. As the briquets are carried forward 300 feet and up to the briquet storage bin they are subjected to a fine spray of cool water which assists in reducing their temperature and in hardening them. They are discharged from the cooling belt on to a cross-conveyer over the bin, transferred to a vibrating baffle, then to another baffle from which they fall into the bin, from which they are discharged through gates to coal cars for shipment. The breakage is practically nil.

The briquets weigh 10 ounces, are cylindrical in shape with a diameter of $2\frac{1}{4}$ inches, height of $2\frac{3}{4}$ inches, with $\frac{3}{8}$-inch dished ends. The comparative hardness of the briquets stated in percentage of breakage under the standard tumbling test employed by the United States Government showed from 10 to 12 per cent. of breakage for the usual commercial briquets, and about 3 per cent. breakage on the Pacific Coast Coal Co.'s product.

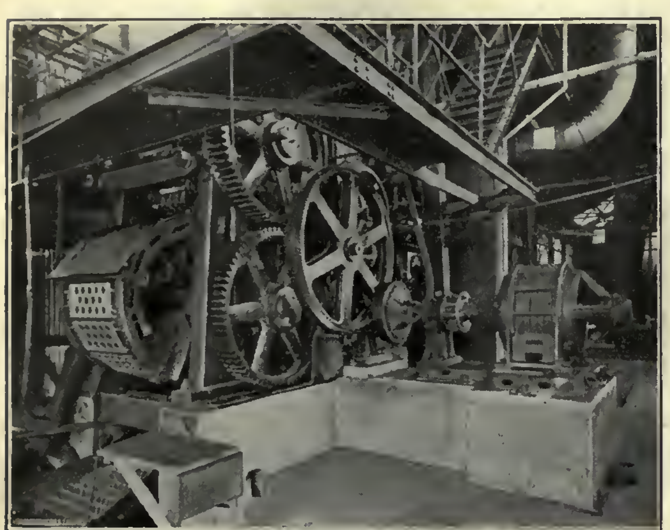


Fig. 5. Briquetting Press

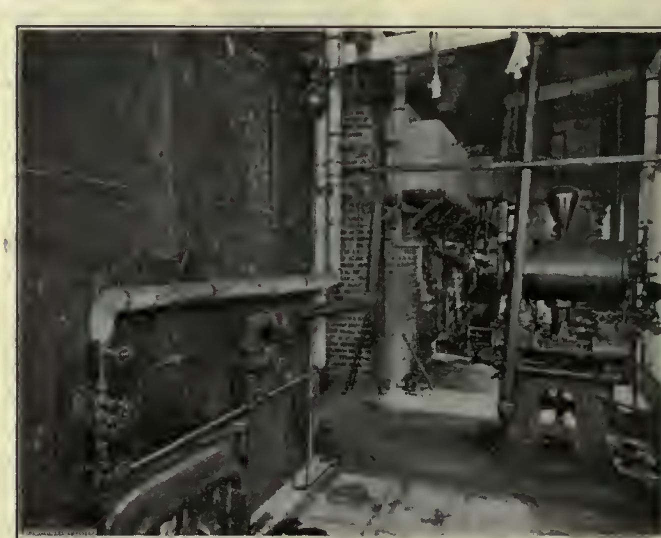


Fig. 6. Asphalt Melting Kettles

Asphalts of the specified grades are received in barrels on the oil spur track from which there is a barrel chute over which they slide to the asphalt yard in the rear and on a level with the charging floor of the kettle house.

There are two asphalt melting kettles of 40 barrels capacity each. The firing end of this equipment is shown in Fig. 6.

At present oil is received in tank cars over the same route as the asphalt and is stored in the steel tank on the side hill, from which it flows through an insulated steam-heated pipe line to the boiler house. Future plans of the company, however, contemplate refining the crude oil at the plant and so obtaining the grade of asphalt required in the briquetting process. Fuel oil will then be a by-product.

Fuel oil circulation is maintained by a pumping system. Asphalt circulation is secured through a rotary pump and by steam-jacketed pipe lines and valves. All circulating pipe lines are insulated with the Johns-Manville Co. asbestos covering.

The asphalt feeding equipment has a steam-heated, insulated, regulating drum located within reach of the operator at the charging end of the paddle mixer. It is his duty to see that the asphalt is maintained at a uniform temperature and head, and that there is a uniform flow through the steam-jacketed valve into the mixer. Provision is made for a steam-heated overflow from the regulator to the kettles; thus the circulation of the asphalt is continuous and the static head is maintained.

Temperature regulation of the binder is not only essential, but that of the coal and steam as well. To this end automatic Bristol recorders giving 24-hour records are placed directly in front of the operator in charge of each movement dependent upon critical temperatures.

Water for the system is heated and filtered by a feedwater heater under thermostatic control.

Superheated steam for the fluxing is generated in the oil-fired furnace shown in Fig. 6, which is capable of raising 2,000 pounds of steam per hour at 150 pounds pressure up to 566° F.

The electric power purchased is delivered at 2,300 volts, alternating current, at the transfer station. It is stepped down to 440 volts for the motors and 110 volts for the lighting circuit, and enters the plant through two main control boards from which it is distributed throughout the works by conductors placed in conduits.

Plant operation is divided into two groups, the dryer group and the press group. Each group has its main control board to permit of direct or automatic regulation of each motor, or of each group as a unit. The dryer group is automatically controlled by an electric tripping device which is thrown by an overflow from the regulating bin.

As the press is the final and perhaps the most important machine in the process, the control of the whole plant, or any group, or unit thereof is directly under the pressman by means of complete bell, light, and speaking-tube systems.

Every machine has an individual motor drive, and where not direct-connected, is equipped with a Link-Belt silent-chain drive, of which there are fifteen in the plant.

There is a machine shop with drill presses, lathes, and other machine tools to provide for the ordinary and immediate repairs.

For a daily check upon all materials used in the manufacture of briquets there is a laboratory and a competent chemist. As this is the first plant to use asphalt on a large scale it has required some careful experimental work and special study of the physical properties of the material

as a binder. Besides investigations of the asphalt, complete analyses are made every day of the coal and the briquets.

For the purpose of determining the value of the briquets for domestic use a demonstrating station has been equipped with a hot-air furnace, a heating stove, a range, a fireplace, and a handling box, the function of the last being to give the briquets such usage as they would naturally receive between the bunkers and the consumers' bins. The industrial efficiency of the briquets as steam fuel is being determined in the company's stationary and locomotive boilers.

Beneath the laboratory and office building, lockers, changing rooms, and shower baths are provided for the comfort and convenience of all the employes.

Automatic control and operation have been given careful consideration in the design and arrangement of the machinery. As a result, a million briquets can be manufactured every 9½ hours, with a total of seventeen employes.

These operators are distributed as follows: The main building takes five, which are the pressman, machinist, mixer, oiler, and dryerman; outside there are two yardmen for unloading coal, three for the asphalt plant, one day and one night boiler and kettle man, one man for loading briquets, a watchman, an extra laborer, chemist, and superintendent.

The plant was constructed under the direction of J. C. Ford, president of the Pacific Coast Coal Co., and his departments of engineering, building, and mechanics, represented respectively by N. D. Moore, D. C. Brown, and D. O'Leary. Field construction was in direct charge of Ralph Galt, briquet engineer, who is now superintendent of operation of the plant.

Briquetting is a distinct branch of the coal company's organization, and its operating superintendent has complete jurisdiction over the work and makes his reports directly to President Ford.

Bituminous Coal Storage

Storing Coal on Land—Loss of Heat Units—Means of Avoiding Spontaneous Combustion—Methods of Handling

Written for The Colliery Engineer

THE storage of bituminous coal presents so many phases from the two angles of wishing and realizing that it requires careful deliberation before a plant is constructed.

FIG. 1. COAL STORAGE PLANT AT BOSTIC, N. C.

Of the three parties most interested the operators and railroad transportation officials come first, the large consumers next, while the general public comes last.

If the operator would store coal, he must have capital or credit sufficient to pay for its mining and transportation, besides solve the more or less speculative question as to whether this would pay. If the storage of coal can be carried on successfully, it offers operators the advantage of steady output, which will diminish fixed charges, and further lessen the cost of production by promoting efficient mining, concentration of work, and uniform extraction. Under these conditions steady output would be feasible only when there are steady daily shipments, for if the coal were stored at the mine and shipped in the cold months when there is so great demand as to cause car shortage, practically the same conditions would prevail as now. It would be impracticable for any coal company capable of producing 2,000 tons per day to keep up such an output 12 months in the year, for the company would probably be compelled to store three-quarters of the coal and possibly would be obliged to make concessions in any case, particularly if other operators were storing coal on the same terms. This brings into the discussion the subject of car supply which in the summer months is 100 per cent. available and which falls in busy times to almost any per cent. below 50.

According to one authority the coal mines in the United States have a capacity for producing coal that is double the consumption; and provided 100 per cent. car supply was available one-half the operators would be forced out of business through destructive competition. This makes another reason why a company should not produce its full output the year around unless it has contracts for it.

With the exception of screenings, all coal not shipped direct to consumers should be stored nearby the market, during the spring and summer months, so as to be available for quick distribution when the winter demand sets in and car shortage begins. During the spring and summer, screenings are in demand, while in the fall and winter domestic sizes are more marketable.

The screenings, which amount to from 25 to 60 per cent. of the production, according to the friability

of the coal and the way it is mined and treated, will increase in the fall and the winter months; and rather than sacrifice them at an extremely low price they should be stored at the mine to be disposed of during the spring and summer months. In this way it will be possible to obtain average prices which will afford profits on all sizes of coal.

Fig. 2. A 100,000-Ton Storage Plant, Gulf Smokeless Coal Co., Norfolk, Va.

Those operators who store coal will have a market advantage over those who do not, because of their ability to deliver promptly in time of need, a feature which appeals to the consumer when strikes or weather conditions have interrupted the usual trend of affairs. Another advantage is that during rush times when there is a shortage of cars, the operator can ship his contract coal direct from the mine, and take advantage of the congestion at the market by delivering coal from the storage piles. These numerous advantages will in all probability prove remunerative, provided the storage piles are located in market centers some distance from the source of coal supply, and the right kind of arrangements for unloading, storing, and reloading are adopted.

A number of experiments made in the past to show the loss in heat units in stored coal have evidently mixed up the volatile matter in coal with the fixed carbon. According to some authorities the loss of heat units during storage in the open air has varied from 12 to 100 per cent., which a moment's reflection will show cannot be true, at least in the latter instance. Messrs. H. C. Porter and F. K. Ovitz give the results of their investigations along the line of coal deterioration in the United States Bureau of Mines Technical Paper No. 16. Their experiments verify the statements made by earlier investigators that climate has much to do with loss of heat units; for example, at Portsmouth, N. H., New River low-volatile run-of-mine coal exposed in the open air for 2 years lost .6 per cent. in heat units. At Norfolk, Va., the same kind of coal exposed for the same period lost .55 per cent., and at Key West, Fla., 1.29 per cent.

They also showed that small ¼-inch coal exposed in the open air in the same locality lost considerably more heat units than run-of-mine coal. Pocahontas run-of-mine coal quite similar to New River coal they found lost .4 per cent. of its heating value in 1 year at Panama, and there was little air slacking of lumps. They also found that Tertiary coal lost more heat units in a given time (5.3 per cent.) than Carboniferous coal. Prof. S. W. Parr and F. W. Kressman state in Bulletin 38 of the University of Illinois, that the loss of heat units in the similar coals of Illinois and Indiana averages from 3 to 3½ per cent. during 12 months. They also state that the loss of heating value is 1 per cent. for the first week, but decreases after that time until it totals about 3 per cent. in 12 months.

Among other objections raised to the storage of coal is its crumbling due to air slacking, but in plants where lump and domestic coal are to be stored, screening plants will be required in almost every case, so that little extra expense will be recorded from this feature.

The most serious objection to storing coal is the danger of spontaneous ignition, due to oxidation. According to observers, coals high in oxygen absorb more oxygen readily, and therefore have a marked tendency to heat until spontaneous ignition takes place.

Where coal is stored in small quantities under favorable conditions there is little danger from spontaneous ignition; but when stored in large high piles particular arrangements must be taken to avoid and cope with fires.

Bulletin No. 46 of the University of Illinois, prepared by Prof. S. W. Parr and F. W. Kressman, enu-

merates the preventive and precautionary measures to be considered when storing coal, and covers the situation so fully that to refrain from quoting them would be neglecting this phase of the subject. They make the following statements:

The first and prime essential is the avoidance of an external source of heat which may in any way contribute toward increasing the temperature of the mass of stored coal.

There must be an elimination of coal dust and fine material. This will reduce the initial oxidation processes of both the carbonaceous matter and the iron pyrites. These lower forms of oxidation are to be looked upon as forces without which it would be impossible for the more active and destructive activities to become operative.

Dryness in storage and a continuation of the dry state, together with an absence of finely divided material, would practically eliminate the oxidation of the iron pyrites.

Artificial treatment with specific chemicals or solutions intended to act as deterrents does not offer great encouragement, though some results seem to warrant further trial in this direction.

By means of a preliminary heating the low or initial stages of oxidation are effected. These sources of contributory heat being removed, the forms of destructive oxidation are without the essential of a high starting temperature, and are, therefore, inoperative. Whether such preliminary treatment is within the realm of practical or industrial possibility could not be determined within the scope of their experiments.

The submerging of coal, it is very evident, will eliminate all of the elements which contribute toward the initial temperatures.

Other processes may be suggested by the formulation of the principles involved. Such, for example, would be the distribution throughout the coal of cooling pipes through which a liquid would circulate having a lower temperature than the mass. This would serve to carry away any accumulation of heat and confine the oxidation to the lower stages only. On the contrary, the proposition sometimes made to provide circulating passages for the transmission of air-currents is of questionable value, since it may result in the contribution of more heat by the added accessibility of

Fig. 3. Large Grab Bucket at Bostic Plant

oxygen than will be carried away by the movement of the air.

Professor Parr showed that there was 1 per cent. loss of heat units in the first week after mining and exposing Illinois coals to the atmosphere, but that the loss decreased gradually from this time on, probably owing to the fresh surfaces becoming oxidized or "seasoned."

Apparently the friability of coals and their susceptivity to air slacking has more to do with their spontaneous ignition than the percentage of volatile matter they contain. For instance, both the low volatile bituminous coals of the Carboniferous period that are friable, and the high volatile coals of the Tertiary period that are friable and slack readily, are particularly subject to spontaneous ignition.

Mr. C. G. Hall, secretary of the International Railway Fuel Association, in the 1914 Proceedings, states that "Atmospheric temperature at the time of stocking is also a factor which should not be overlooked. With summer heat of 100° F. or greater prevailing for 6 weeks during the time coal is being stored, and especially if the weather is dry during this period followed by a shower, and then further dry hot weather, it has been the experience of one railroad that coal will fire spontaneously within a period of 6 weeks, even though it be large 6-inch lump and piled only 4 or 5 feet high." It would appear, therefore, preferable to store coal in April and May, than in June and July.

When practicable, it is also desirable to hold coal in cars or in small piles 6 weeks after mining to allow it to pass through the "seasoning" stage, after which it can be placed in piles 15 to 20 feet deep with comparative safety.

Spontaneous ignition is sometimes due to slow oxidation of coal in an air supply insufficient to carry away the heat so fast as it is generated. When the accumulated heat reaches a temperature of 200° F. the rate of oxidation is increased, and if the oxygen supply is adequate the coal takes fire. When once the coal commences to glow the most satisfactory way of disposing of the fire is to shovel it out. According to Messrs. Porter and Ovitz, run-of-mine coal piled so that a small supply of air will enter the interior of the pile furnishes ideal conditions for slow oxidation.

Because of demurrage charges it is hardly possible for the shipper to keep coal in cars 6 weeks while it seasons, but it is possible to stack the coal at the mines for that period, and then ship it to the market storage pile.

In order to unload the coal and stack it with least breakage, the hopper-bottom coal cars should deliver into a pit beneath the track and a scraper line deliver the coal either to the pile or where a locomotive crane with a clam-shell bucket can reach and handle it to advantage. The use of clam-shell buckets and cranes for unloading or raising coal from a pit for stacking is preferable to the use of scraper lines, for the reason that the crane and bucket simplifies and economizes in the work.

Messrs. Porter and Ovitz advise that, in stacking, the coal be placed in piles so that no large lumps run down the sides, as such stacking creates spaces through which air for oxidation can circulate, and thus offers a possible opportunity for

spontaneous ignition. They also quote examples in corroboration of this statement.

Mr. W. P. Tams, Jr., president of the Gulf Smokeless Coal Co., decided to have a storage plant at Norfolk, Va., and to this end enlisted the services of the Link-Belt Co.'s engineers. The capacity of the plant is 100,000 tons and it is constructed substantially as follows: There are two concrete pits, 25 ft. × 30 ft. in area and 22 feet deep, over which hopper-bottom coal cars are run. The coal is discharged from these cars, by opening the doors of the hoppers, into the pits, which hold about 100 tons each. A locomotive crane of 100-foot radius, with a large clam-shell bucket, lifts the coal from the pit, and swinging it around, deposits it on the ground. As can be seen from Fig. 2 the locomotive-crane tracks encircle the two pits at a distance of 100 feet, which is the radius of the crane arm, and gives the crane tracks the form of the figure 8. The clam-shell bucket used has a capacity of 3 tons. This plant has an unloading capacity of 175 tons per hour, and a reloading capacity of about 200 tons per hour.

The use of long-armed locomotive cranes has proved more economical in first cost and in moving coal than traveling cranes for temporary coal-storage plants, although on docks they are not so suitable as the latter.

At one plant which carries about 20,000 tons in storage, the coal arrives in gondolas and is unloaded direct by the crane and bucket, except the small quantities that the clam shell is too unwieldy to gather in its maw.

Coking coal is more friable than other bituminous coals, also is more readily air slacked, in which condition it loses its coking properties in time. At by-product oven plants it is necessary to keep a stock pile of sufficient size to last several days in order to assure continuous operation of the ovens in case there should be a tie-up of transportation.

The circular type of crane is not entirely satisfactory in such places because it is difficult to arrange the coal so that the oldest can be raised first, and this difficulty increases where a number of different coals are stocked and are proportioned to make an oven charge. At one oven plant where the coal is stocked 30 feet high, it has caught fire several times on the edges of the pile but not in the interior. The cost in cents per ton when operating a circular, 20-foot gauge, Dodge coal storage crane, where the coal is unloaded from steel hopper cars, is approximately as follows:

Cost of Unloading	Cents
Labor	2.5
Repairs	.3
Electric power	1.6
Total	4.4
Cost of Loading	
Labor	1.4
Repairs	.3
Electric power	1.4
Total	3.1

Cost of loading and unloading 7.5 cents per ton.

The Clinchfield Fuel Co. with headquarters at Spartansburg, S. C., mine coal in the Clinch Valley of Virginia, at Dante. This coal is shipped south over the Carolina, Clinchfield & Ohio Railway, to Spartansburg, and then over various railroads to interior and coast cities. L. S. Evans, vice-president of the company, kindly furnished the data on the Bostic, N. C., plant and the cost of loading and unloading with a "whirly" or locomotive crane.

The plant, a part of which is shown in Fig. 1, has been operated 3 years in succession. It has been found useful during the summer months to provide a place for surplus coal and thus help to keep the mining organization intact, and during the season of heavy demand for coal it has supplemented the mine shipments and enabled the company to fill orders with promptness. The coal is piled 35 feet high on each side of the trestle which is about 800 feet long and upon which the railroad cars are placed for dumping and also for reloading. The piles at the latter end of the season may attain approximately 150,000 tons, and so far there has been no case of spontaneous ignition, although some of the coal has been in storage 2 years.

The "whirly" operates on a track 16 feet wide and, with a reach of 60 feet, puts the coal in piles by means of a 2½-ton grab bucket and also reloads it. In each of the piles there is a pipe penetrating to the center, so that temperatures may be regularly taken.

The company intends also to build a storage plant at Charleston, S. C., where ships may be loaded without delay.

The cost of operating the storage plant at Bostic, N. C., will prove of interest to those who contemplate coal storage.

When these data were furnished reloading had not commenced for the year.

It is the custom to ship large quantities of coal through the Great

Cost of Operating Coal Storage Plant at Bostic, N. C.

Unloading Cost, June 24 to October 4, 1912

		No. of Tons	Cost Per Ton
Pay roll	$2,148.74		.0172
Repairs to plant, supplies, etc.	373.14		.0029
Fuel for crane	594.50		.0047
Total	$3,116.38	125,696	.0248
Depreciation at 10 per cent. per annum on $71,000 for 6 months	$3,550.00		.0282
Interest at 5 per cent. for 6 months	1,775.00		.0141
Total	$5,325.00		.0671
	$8,441.38		

Reloading Cost, October 8 to January 31, 1913

		No. of Tons	Cost Per Ton
Pay roll	$1,797.62		.0138
Repairs to plant, supplies, etc.	727.44		.0056
Fuel for crane	646.70		.0050
Total	$3,171.76	129,778	.0244
Depreciation at 10 per cent. per annum on $71,000 for 6 months	$3,550.00		.0274
Interest at 5 per cent. per annum on $71,000 for 6 months	1,775.00		.0137
Total	$5,325.00		.0655
	$8,496.76		

Total average cost for dumping and reloading 13.26 cents per ton.

UNLOADING COST
From May 1 to August 31, 1914, Inclusive, 2,703 Cars

	Amount	Number of Tons	Cost in Cents Per Ton
Pay rolls	$1,653.74	131,949	.0125
Repairs to plant, supplies, etc.	576.72		.0044
Fuel for crane, estimated 2½ tons per day	600.00		.0045
Total	2,829.46		.0214
Depreciation at 10 per cent. per annum on $71,000 for 6 months	3,550.00		.0269
Interest at 5 per cent. per annum on $71,000 for 6 months	1,775.00		.0135
Total	$8,154.46	131,949	.0618

Lakes and place it in stock piles which are drawn on during the winter months, in many instances the year around. The ore mines near the Great Lakes generally have their own docks and storage piles, as also do the railroads, but several large coal companies have storage piles from which they deal out coal for the use of the general public. Some of these storage plants and the machinery and methods that are being employed in their operation were fully described by J. F. Springer in the July and August, 1914, issues of THE COLLIERY ENGINEER.

A Saw-Tooth Colliery Building

The J. Wooley Coal Co. saw it first and now others may wonder why they did not think of the saw-tooth construction for power house purposes, since it furnishes more light and can be constructed in sections as occasion demands.

FIG. 1. TIPPLE AND POWER HOUSE WITH SAW-TOOTH ROOF

Heretofore it has been customary to build a power house larger than the actual requirements demanded so that in case extra power should be needed the space would be there for the instalment. Sometimes the space is never needed, at other times it becomes necessary to wreck a part of the building to make room for the instalment, and in all cases good money is locked up in the plant for an indefinite time.

At the Paxton, Ind., plant of the J. Wooley Coal Co., Allen & Garcia designed the saw-tooth power house shown in Fig. 1 and in detail in Fig. 2, that can be added to at any time if it becomes necessary to increase the power plant, and that too without destroying the symmetry of the building.

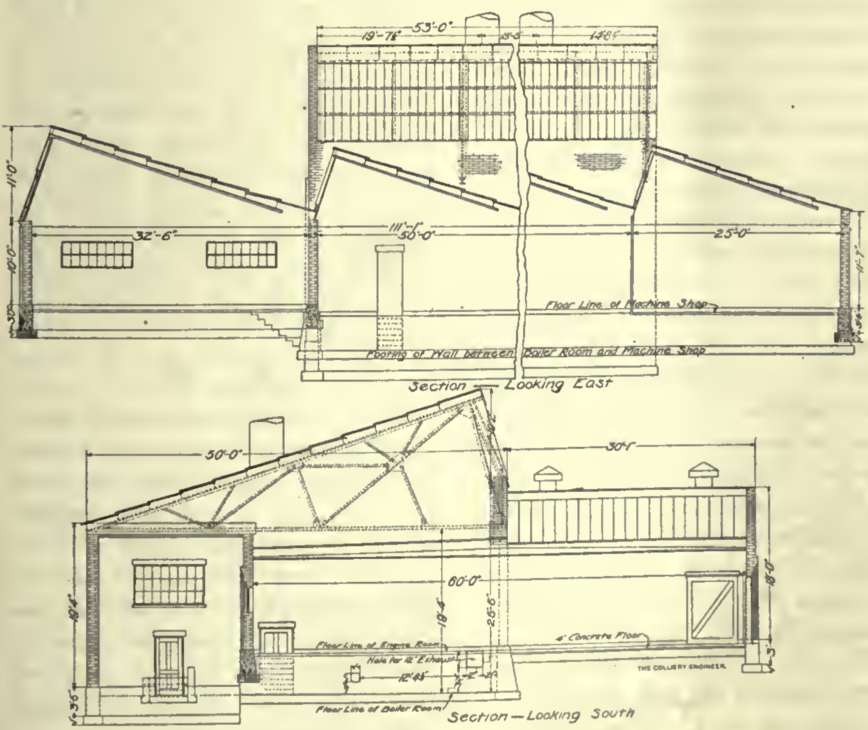


FIG. 2. SHOWING CONSTRUCTION OF SAW-TOOTH BUILDINGS

In addition to the side windows, the short side of the tooth is glazed and admits light to all parts of the interior, making it a "Safety First" feature. The slant to the tooth or roof is constructed of tile, and the side walls of brick, one end wall of brick, and the other end of a temporary construction easy to remove in case of more room being required.

The section nearest the shaft contains the hoisting engine and dynamos. The next section contains the boilers, the following sections being divided into machine shop, blacksmith shop, and supply room. It is unnecessary to elaborate on the advantages of this combination of departments under one roof, which are as separate from each other as if in different buildings, nor is it necessary to explain that less capital expenditure is involved for buildings, hence less interest charges, taxes, and if of fireproof construction insurance premiums.

Coroner's Report on Mulga Disaster

Condemning the action of the officials of the Mulga mines of the Woodward Iron Co. for not taking proper precautionary measures to safeguard the lives of the workmen in the mines and making certain recommendations, the jury impaneled by Coroner Spain to investigate the Mulga mine explosion, which occurred October 5, in which 16 lives were lost, made its report October 15. The jury was composed entirely of practical miners, all of whom have worked in and around Pratt mines for the past 25 years.

They were impaneled on October 12, at Birmingham, Ala., and during their investigations visited the scene of the disaster and examined the headings and rooms where the men were killed.

The report follows:

"Inquest over the remains of Ed. King, C. R. Combell, John Zalemski, Bob Dupion, Joe Malcoskie, Wilet Pilcoski, John Krativick, white; Scott Garret, Warren Whatis, Hamp Swanson, Cory Howard, W. M. Long, Joe Bragoon, Bert Webster, Tom Mitchell, and Sam Chatman, colored.

"We, the jury duly impaneled by the coroner of Jefferson County, on, to wit, the 12th day of October, 1914, to inquire into the cause of death of the above mentioned, who met their death at the Mulga mines, Mulga, Ala., on October 5, 1914, having diligently investigated said cause, taking all the testimony obtainable; we agree that the deceased came to their deaths by an explosion of gas at Mulga mines, October 5, 1914, caused by the trap door in the eighth right heading being broken down and not being replaced for a period of approximately 1 hour. The air was short circuited, causing an accumulation of gas in the eighth and ninth right headings and rooms, and as there were men working in said headings and rooms with naked lights, the gas accumulated, coming in contact with these naked lights caused the explosion, which resulted in the death of aforesaid parties.

"We find that the trap door was knocked down with a carload of ties attached to an empty trip in charge of Ed. Lee, colored, motorman, and Jackson Rodgers, colored, trip rider. This motorman, Lee, and trip rider, Rodgers, were not the motorman and rider who went into the eighth right heading regularly, but were only placing the carload of ties, which were for use in the eighth right heading. The trapper boy at the door on the eighth right heading wanted to open the door, but the trip rider, Rodgers, told him he was not going through the door so not to bother to open said door. But said Rodgers must have miscalculated the distance as we find that the car of ties crashed into the door and broke it down, frame and all; therefore short-circuiting the air and depriving the said eighth and ninth headings of the proper amount of ventilation necessary to keep down the gas which was being produced in said heading.

"Therefore, in view of the forego- that as the ventilation of said eighth and ninth headings was cut off and impaired, we condemn the action of the company officials for not taking proper precautionary measures to safeguard the lives of the workmen in said eighth and ninth headings by calling them out from the danger zone in said headings until such time as the circulation of the air was restored as would again make it safe to continue working in said eighth and ninth headings.

"Therefore in view of the foregoing verdict, we, as jurors, recommend that in all mines, generating gas, that as soon as practicable overcasts be put in on all headings and the use of the trap doors be discontinued as far as possible. We also recommend that when the air is short-circuited, or the ventilation of any mines be impaired so that it is dangerous to human life and safety, that it be the duty of the management to call the men in said mines to a place of safety.

"We also recommend that in all mines generating gas the fire boss examine the working places no more than 3 hours before the working man goes to his place of work."

John Guthrie,
M. J. Shenlin,
Wm. Muir,
Sam Brodie,
Joe Hoskins,
James Liddell.

C. L. Spain, Coroner of Jefferson County.

Water in Mines

In the anthracite regions of Pennsylvania, the mine operators pay out nearly $600,000 a year for pure fresh water. This is necessary, after pumping over 1,000,000,000 tons, or approximately 300,000,000,000 gallons of water a year out of the mines, for on account of the destructive quality of the mine water, very little of it can be used in the boilers.

Mine water is so charged with sulphuric acid that the disastrous effect of the acidulated water on iron necessitates the frequent renewal of miles of pipe in the mines. A pipe line laid new early in April has been known to be ruined by July.

One company bought 1,316,369,965 gallons of water last year for which it paid $109,494.76, and consumed nearly 100,000,000 gallons at one colliery. The total quantity of fresh water bought by the anthracite coal operators last year is calculated to be 7,115,573,324 gallons and the cost $591,863.56. This is generally conveyed to the mines by pipe lines from the springs and streams in the mountains, but in times of drought much of it has to be actually hauled to the mines in tank cars from many miles away.

Utah coal producers have asked the Government to use coal for the Pacific fleet produced by the mines of Utah. The fleet is now supplied by the Virginia mines, but if it can be transferred there, it will mean an increased production of 100,000 tons from Utah. All Utah producers, including the United States Smelting Co., have asked the Navy Department to take immediate action.

Rock Work in Coal Mines

Conditions Which Make it Necessary—Kinds of Drills—Methods of Placing Holes to Break Rock

Written for The Colliery Engineer

IN A few of the coal fields of the United States no rock work is required, but in the majority of coal mines rock blasting in some form is carried on in order to facilitate operations.

In thin flat beds the roof or floor is brushed in haulage entries, to furnish head room; in thick flat beds, rolls are blasted to furnish a uniform grade, and "swags" are blasted down to furnish head room. Very few faults are found in the coal fields east of Colorado; however in the mountain states of the West there are plenty, but while the coal beds are not so contorted as in the anthracite fields of the East they are frequently inclined and so faulted as to make it necessary at times to drill and blast rock. The anthracite fields in northeastern Pennsylvania have been so folded and contorted that it is frequently necessary to drive rock tunnels in order to work them efficiently. The section in Fig. 1 shows a condition which is mild compared with some in the anthracite fields, but it illustrates why tunnels and rock slopes are indispensable to economic coal mining.

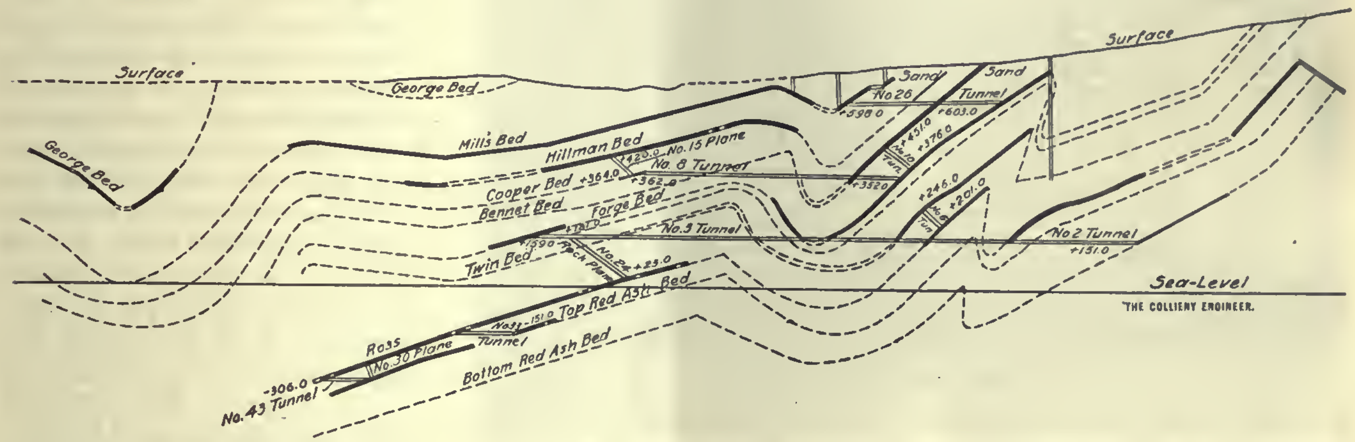


FIG. 1. SECTION IN TRUESDALE COLLIERY

Where head room is required in thin coal seams the decision as to whether the roof rock shall be taken down or the floor rock taken up depends on the respective hardness of the rocks, unless some particular object is desired. If there is little or no water or gas to contend with, roof is brushed when it is easier to drill and handle than the floor; but if the roof were hard compact sandstone or limestone the floor would probably be cheaper to brush.

If the roof is good for a short distance above the coal and above that is soft and shaly, it possibly will be better to lift the floor, but conditions vary so continually at mines that the matter of "brushing" must to a great measure depend on the intelligence of the manager. Where the floor "creeps" it should be lifted and the roof left undisturbed so far as possible; again, where thin beds of coal are worked and scraper lines are used to convey the coal to the entries, the floor is lifted.

Entries in low coal are driven wider than in higher coal for safety and for ventilation.

When bottom rock is lifted, the entry should be as wide as the car and 3 feet additional each side, and refuge holes made in the rib if there is much traveling on the road. If the rock from brushing the entry is not to be carried out, the coal must be removed so that it may be gobbed along the sides of the road. In hard rock, machine drills or hand drills and hammers are used,; if the rock is soft, auger drills; and in between hard rock and soft rock ratchet drills will be found serviceable. Where rock slabs, there is not much difficulty in making fair headway in brushing, but where rock is compact the work is difficult and slow.

The method of brushing followed in Arkansas coal mines* is shown in Fig. 6. The roof in this instance slabs, is too hard for breast augers, but not so hard as to require percussive drills, therefore post drills and rachet drills are employed, the latter only when the rock is too hard for post drills. The holes for blasting down the roof are usually three in number. One is placed directly over the center of the track and parallel and one drilled each side of the center at about the direction shown by the auger in Fig. 5.

To the left in this illustration is shown a line of breaking props placed 12 to 16 inches apart along the entry and about 2 feet back from the track. The roof breaks over the track to this line on one side and the rib on the other side after being shot. If this rock was hard compact sandstone there would be one or two additional breaking posts in line and behind the one shown if it was considered advisable to hold the top rock, a matter which only experience can determine.

In taking up floor, the coal would

*A. A. Steel, MINES AND MINERALS, Vol. 32, p. 10.

be first removed as in the case of brushing the roof, and then the best method of breaking the rock bench is to be investigated. It may be necessary to put in center cut holes, and after these are fired shoot side holes; or it may be advisable to drill

Fig. 2. Conveyer Carrying Coal in Thin Seam

back holes and throw out the bench, or again lifting holes, first firing the holes in the center and then those each side. Conditions may vary so widely that experimental drill holes should be tried in different positions and the best method of breaking thus established.

In work of this kind the intelligence of the miner will determine the most efficient method to be followed, as no rule will apply to more than local conditions.

In many practically horizontal coal beds there are found rock rolls in the floor and horses in the roof, which require blasting if the haulage roads are to be kept to a uniform grade. Even if the roof is good and strong and holds back water, it may be necessary when the swag is abrupt to blast it down, and make arrangements for permanently supporting the excavation at this place.

In most coal mines air is carried under or over the main airway by means of overcasts or undercasts, which as a usual proposition are made by blasting out rock, particularly in flat beds. It frequently happens that in between two coal beds there will be a bench of rock which will vary from an inch to several feet in thickness, but only in the latter case will much rock work be required. Where coal measures are inclined and contorted as in the anthracite fields, rock work is a necessary part of mining. Take for instance the section Fig. 1, where tunnels are driven across the coal measures to intersect the various beds, and where rock planes are made necessary for ventilation and haulage purposes. In addition to rock tunnels and slopes, underground tunnels are frequently driven above water level to cut coal beds, and finally shafts are sunk from the surface for the same purpose.

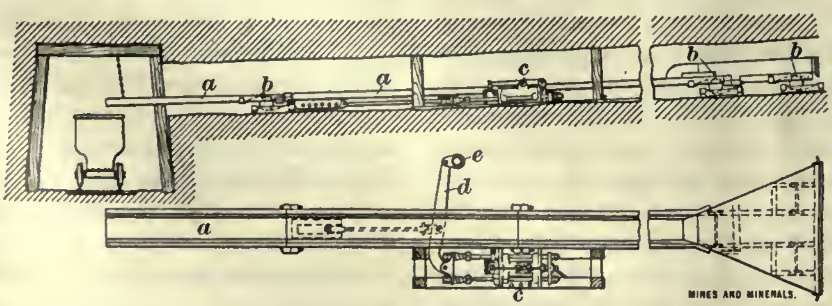


Fig. 3. Showing Floor Taken Up

In rock work of this description the hand hammer and drill or the compressed air drill are used, the auger drill being unable to penetrate hard rock quickly. In tunnel driving the holes are arranged to break the greatest quantity of rock with the fewest number of holes. Explosives, while of course an object of economy, are not so costly as rock drilling as a rule; further, the price of explosives being based usually on their strength, the cost may be averaged by varying the strength of the explosives used. As the tunnels in coal mining are comparatively small they are not worked in benches, and to obtain two free faces cut holes are drilled in the face to blow out a wedge-shaped piece of rock. These holes are 1 to 8 inclusive in Fig. 8, the arrangement being termed the "square cut," or American method. The side holes *c* and *d* are drilled before the center-cut holes are fired. The center holes are charged with 70-per-cent. dynamite and the side holes with from 40 to 60-per-cent. dynamite, the object being to break so much rock in the center that the side holes, having two free faces to play on, will not require such strong explosive. The number and inclination of the holes depend on the kind of rock; the metamorphosed rock of the anthracite fields will break as readily as the sand rock of the bituminous field, while the "mountain limestone" will not break so easily as either of the above. So far as drilling is

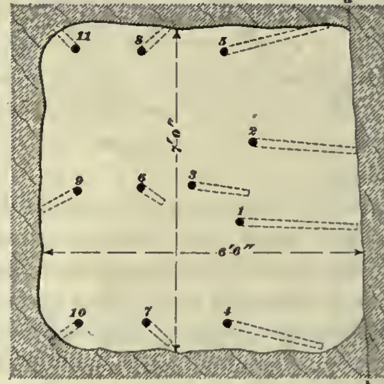


Fig. 4

concerned, the order of progress will be as follows: sandstone of the bituminous fields, metamorphosed rock in the anthracite fields, and "mountain limestone" of the central and western fields.

This order of hardness for drilling and blasting is for compact rock free from seams and fractures. The size of rock tunnels in coal mining is 8 ft. × 7 ft. although many are driven 7 ft. × 7 ft. and 7 ft. × 6 ft.

While the American cut sometimes works poorly, better results are often obtained by varying the positions and direction of the holes. The secret of a good break is in giving the cut holes sufficient pitch and putting them in deep. In one case the cut holes were put in as shown by dotted lines X and E in Fig. 9, but experimental work finally established their positions as shown by the full line holes 1, 2, 5, 6, 7, and 8 which eliminated the four holes X and E, so that 16 holes did the work of 20.

The "Leyner cut," shown in Fig. 10, furnishes a pyramidal center cut and has increased the progress in tunnel driving in several instances.

While the positions of the holes are shown for hard rock they may be modified; for instance in softer and better breaking ground cut holes 5 and 6 and relief holes X and Y and one lifter and one plunger might be left out. The holes are drilled by machines placed on a cross-bar at A. From the top of the bar, the back holes 9, 10, 11, and 12 are drilled, after which the machines are depressed so as to drill holes 1 and 2. The machines are then turned under the bar and side, holes 7 and 8 and cut holes 5 and 6 drilled, after which the bar is moved to the position B. The machines are set on top to drill holes 13 and 14 and then tipped up so as to drill holes 3 and 4. Four lifting holes 15, 16, 17, and 18 are next drilled and sometimes the relievers X and Y. The Leyner drill uses water and the upper holes are drilled more easily by this machine and with less injury to the drill runners' lungs, therefore this system of placing holes has received the name "Leyner cut."

Fig. 6. Beginning an Entry in Low Coal

The "Billy White" cut, although originated in Cornwall, England, has found many advocates in this country. The three holes 1, 2, and 3, Fig. 7, are drilled straight into the face in line with one another and at distances of 5 inches center to center. Another hole 4 is drilled 7 inches to the right of 2, and hole 5 is drilled 12 inches to the left of 2. The holes are given just pitch enough to hold water, since the success of the cut depends on the holes being in planes with one another and in shooting them in rotation. Four of the holes are loaded in the usual manner, No. 2 hole, however, is not charged but is drilled to provide a space for hole No. 1 to break

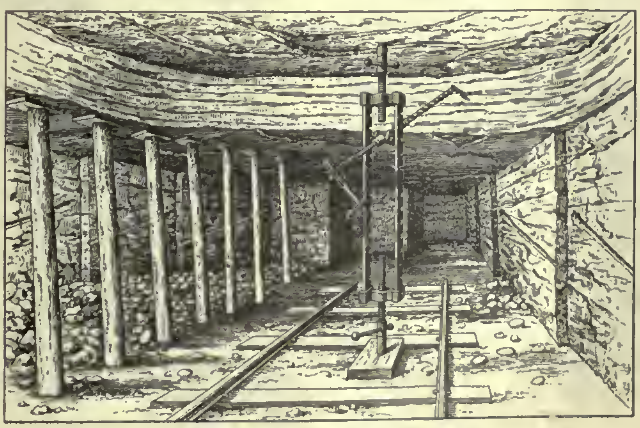


Fig. 5. Brushed Entry in High Coal

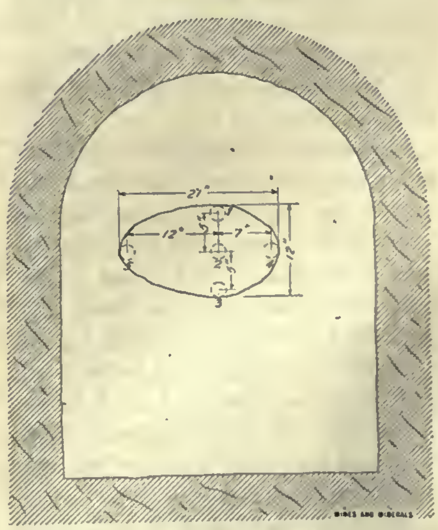


Fig. 7. The "Billy White" Cut

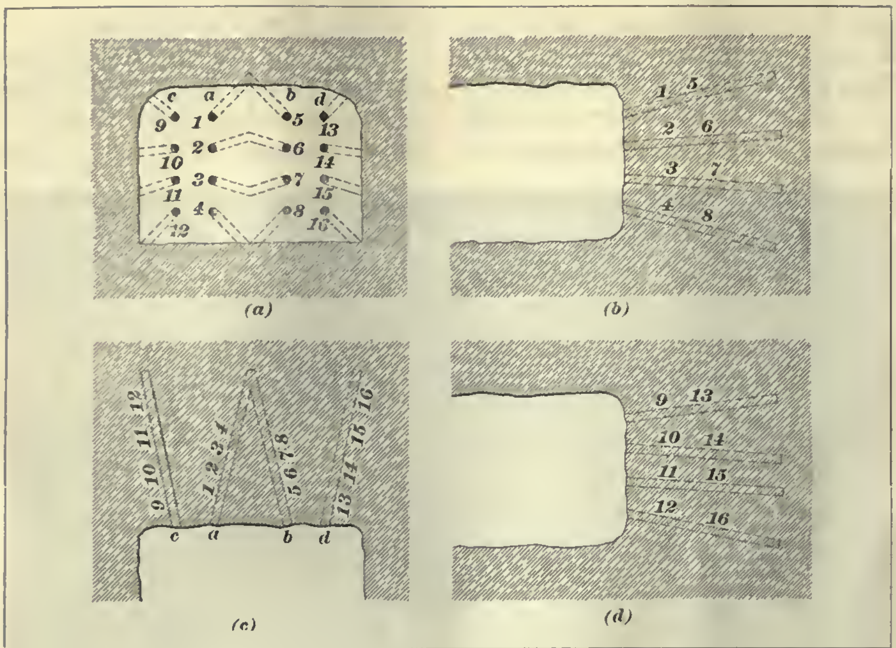


Fig. 8. The Square Cut

to. The fuses are cut in different lengths to fire the holes in about the following order: 1, 3, 4, and 5. After holes 1 and 3 have exploded, the hole made is about 12 inches vertically by 5 inches horizontally, but after all the holes have been fired it is about 12 in. × 12 in. The hole breaks as big at the bottom as at the collar and will break 6 feet deep; at the same time the cut takes no more powder and often less. The full bore of the tunnel is obtained by placing holes that will break to this initial cut.

The entering cut to which the subsequent holes are to break need not be in the center, in fact it is often necessary to make a cut hole to the side of the excavation both for convenience and to conform to the cleavages, joints, etc., in the rock.

Fig. 4 shows one method of placing a side cut where there is a slip *a b* to the right and advantage is taken of it to make the entering cut. The holes 1, 2, 4, and 5 are drilled from one column and the holes 3, 6, 7, 8, 9, 10, and 11 are drilled from a second column. Holes 1 and 2 are fired together, then 3, 4, and 5 consecutively. In the third round, holes 6, 7, and 8 are fired, and in the final round 9, 10, and 11.

In shaft sinking, the rock work differs from tunnel work, not so much in the method of drilling and placing holes, as in dealing with the water and in handling the rock after it is broken.

To insure good mine ventilation see that the airways are large and kept free from rock falls.

Tobin Bronze

The exact mixture composing Tobin bronze, so largely used about mines for pump piston rods, pump cylinder linings, condenser tube sheets, bushings, valve faces, valve stems, etc., is not published. It is suitable for the impellers and linings of centrifugal pumps, where the mine water is acid. The specific gravity of the metal is 8.404; a cubic inch of the metal weighs .3036, and its melting point is 1,600° F. It is practically acid proof but not grit proof. It will not strike fire, and therefore is used for powder press plates and powder tools. Rods not larger than 1 inch in diameter have a minimum tensile strength of 62,000 pounds per square inch; when larger than 1 inch in diameter the tensile strength is 60,000 pounds per square inch. The minimum elongation for rods not larger than 1-inch diameter is 25 per cent. in 2 inches, and for all rods larger than 1-inch diameter is 28 per cent. in 2 inches. A rod of Tobin bronze submerged in one-third concentrated sulphuric acid for 5 months lost .0025 per cent.

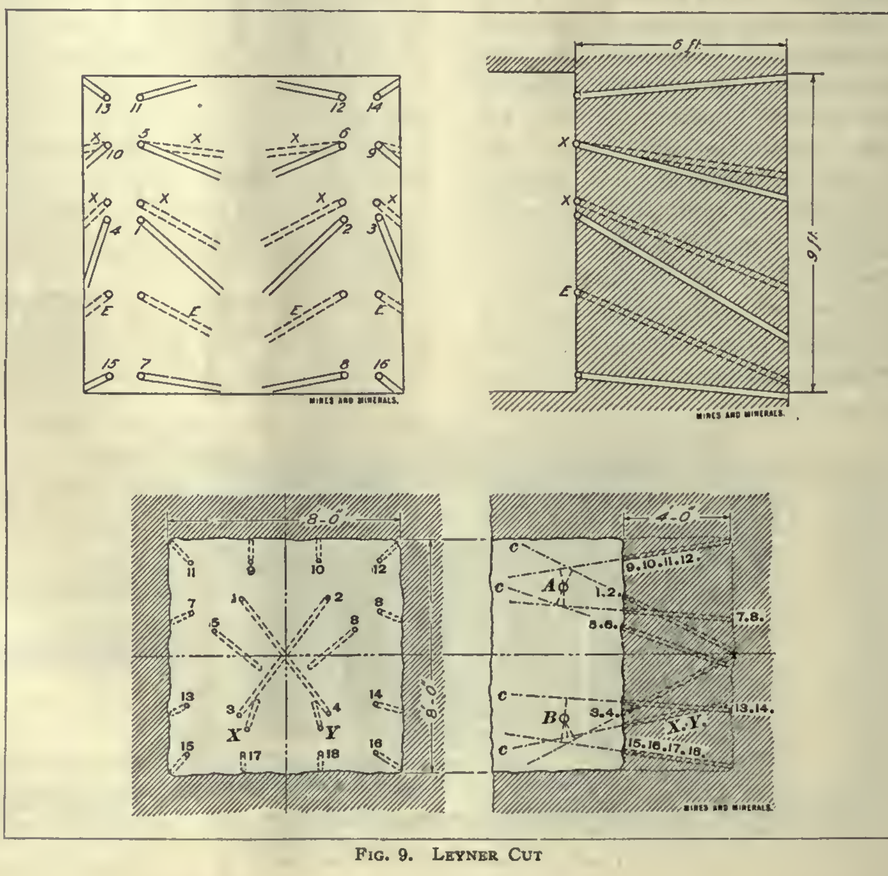


Fig. 9. Leyner Cut

Mine Motors

With Special Reference to Electric Motors—The Various Types of Commercial Motors and Their Peculiarities

By Everett Drennen, E. M.*

THE subject, "Mine Motors," is too broad to be covered by one paper, and to be practical, more attention will be given to results accomplished than to the theoretical processes of the operations.

An electric motor is primarily a means of converting electric energy into energy of motion for the accomplishment of work.

The property of an electric current to produce rotating motion was accidentally discovered by Faraday as far back as 1821. He was experimenting with a magnetic field and accidentally suspended a loop of wire and noticed the effect of the field. He later deduced the properties of a magnet to rotate about a fixed current or about its own axis. About 10 years later he constructed a motor by using horseshoe magnets and two coils of wire, with string between the wires for insulation, wound on blocks of wood. Thirty-five years later a philosopher by the name of Wilde replaced the fixed horseshoe magnets by electromagnets and a few years later the one coil was replaced with a series of coils by the man Gramme, to whose credit the electric dynamo is placed. This principle of a dynamo upon which Gramme's invention was based is that magnetic influence exerted in certain lines radiating from the poles of the magnet may be cut and the energy collected by passing a closed loop of wire through them. The current or electromotive force set up in this wire depends on the rapidity of revolution or passing the field, the strength of the magnet, and the angle at which the wire passes through the field. The current set up by such action does not flow in one direction, but consists of a series of reversals in opposite directions.

Up to this point alternating-current and direct-current machines in the present-day construction are similar. In one, however, the current is transmitted through conductors and used as it is generated in the machine, that is to say, in a series of starts and stops or complete reversals, such being called the alternating current. In the other by introducing into the dynamo a device called the commutator, the current produced in the armature is, so to say, straightened out or flows in one direction and there is then obtained what is called the continuous current.

Today, electric motors, or reversed dynamos of essentially the same construction as Gramme's machine, are operated on alternating-current and direct-current circuits as the convenience and economy of operation may suggest. It might be well to discuss briefly the various types of commercial motors in practical service in connection with mining operations before dealing with the direct application to these various operations.

Alternating-current motors for single-phase, two-phase, and three-phase circuits are used for mining operations on practically all standard voltages, from 110 to 6,600. The standard commercial voltages for alternating-current, three-phase, direct-motor operation are 110, 220, 440, 550, 1,100, 2,200, and 6,600, corresponding to the standard transmission voltages for delta connected equipment. While motors may be operated on the same circuits connected in Y, the voltage figures in this case should be multiplied by the square root of 3 or 1.732.

Three-phase transmission at the above voltages has become the recognized standard and it is hardly consistent with a practical handling of this subject to speak of the single-phase two-wire, two-phase four-wire, two-phase three-wire, or three-phase four-wire transmissions. The motors that operate on these circuits differ from the three-phase motors only in the method used in winding them. While it is possible to use any of the above systems for mining operations, the three-phase three-wire and the single-phase two-wire for series-wound motors are the only practical ones in operation. The six-phase motor is sometimes used, but is hardly practicable.

The purpose of high voltage transmission of alternating current is based entirely upon economical construction and operation, and should conform where practical to 1,000 volts per mile of transmission. While motors are rarely operated on voltages higher than 6,600, transmission lines are constructed for voltages up to 110,000. The nicety of commercial electrical practice is demonstrated in the fact that the voltages for the standard delta connected equipment are all multiples of the lowest commercial voltage in use.

Alternating-current motors are divided into two classes, synchronous and non-synchronous motors, the latter class of which is subdivided into induction motors of the squirrel-cage and wound-rotor type, and the single-phase series motor.

Synchronous motors operate in parallel with the generating unit in precisely the same manner as a second generator would be made to operate in parallel with this generator; it is practically a reversed generator. This type of motor requires separate direct-current field excitation, which is often an inconvenient feature in connection with their operation under ground. It is generally built with revolving heads composed of laminated steel cores wound with insulated wire for the direct-current excitation.

The non-synchronous induction motor is manufactured in two types, the squirrel-cage and wound-rotor types. The so-called squirrel cage is practically the same as a self-

*Abstract of a paper read before the Kentucky Mining Institute.

starting synchronous motor, excepting that it does not have field coils wound for direct-current excitation. The fields on this type of motor have only the squirrel-cage winding. As the general name "induction" infers, this type of motor requires no sliding contacts. It is especially adaptable wherever constant speed is required. It has three to four times full load torque at starting. Its construction is extremely rigid and the motor is less affected by dirt than any other known type.

The wound rotor induction motor differs from the squirrel-cage type in the rotating element only. In place of the squirrel-cage winding, which is simply a winding consisting of straight copper bars all connected at both ends by a copper ring, wire-wound coils are used in the rotating element, and these are connected to collector rings on the shaft of the motor. Carbon brushes collect current from these rings and in turn connect through a controller to resistance.

The alternating-current, series-wound, single-phase motor is practically the same as the direct-current, series-wound motor, excepting that resistance is usually placed between adjacent commutator segments to reduce the induced current in the coils which are short-circuited by the brushes. This motor can be operated on a direct-current circuit very well, but a direct-current, series-wound rotor is not so suitable for service on an alternating-current, single-phase circuit, due to the above construction.

Direct-current motors are operated in connection with mining very extensively. The practical range of voltage for this class of work is from 110 to 500, while the most common voltage in use underground today is 220 or 250. All direct-current motors are commutating motors and the difficulties incumbent with this feature limit the voltage as above stated. Direct-current transmission which is more economical at the same voltage than any form of alternating-current transmission, should be limited where practicable to 1 mile for 250 volts and 4 miles for 500 volts.

A series-wound motor consists of a revolving armature built of form-wound, or hand-wound, coils placed in slots in a laminated steel core. This steel core is either keyed direct to the shaft or held by a cast-iron spider which is in turn keyed to the shaft. The ends of the copper coils in the armature winding are brought out to one end or neck of the commutator bars and soldered. This makes two or more continuous circuits from any point on the commutator to any other point on it. The field consists of form-wound copper coils placed over laminated, or cast-steel, pole pieces. Two, four, or six pole motors are used in mine service and these poles are placed equally about the armature. As the name implies, the fields are connected in series with the armature for the purpose of producing excitation that will vary in proportion to the load. Thus, the series-wound motor is adaptable to variable speed loads where a high starting torque is required and the load is never less than a fixed amount.

The shunt-wound motor has the same general construction as the direct-current series-wound motor, excepting that the fields are wound with finer wire and connected directly across the line and not in series with the armature. The shunt-wound motor is practically a constant-speed motor with a constant torque. It is adaptable to uniform loads where excessive starting torque is not required.

The compound-wound motor is a combination of the series and shunt-wound motor, having the same armature construction and shunt field coils with small series fields superimposed. For a motor of given horsepower at a certain speed a compound-wound motor would be designed for the same full load speed as a shunt-wound motor. Thus, on light loads with a corresponding loss of effective field strength by reason of the series field carrying current only in proportion to the load, the speed of the compound-wound motor would be greater than that of the corresponding shunt-wound motor. This feature works out to advantage in that starting under heavy load the field strength of a compound motor is increased, thereby increasing the torque at starting. This motor is adaptable for operating under fluctuating loads because the torque varies, as mentioned, in proportion to the load.

All direct-current motors can be built with auxiliary poles called "interpoles," which assist the weakest point in connection with the operation of direct-current motors, viz., the commutating feature. An interpole is a series coil placed on a small pole piece midway between two adjacent main poles or fields. Interpoles are placed between each two main fields. The object of these interpoles is to set up a flux that is equal to and in opposition to the flux set up by the armature. This prevents the shifting of neutral points on the commutator, thereby providing for sparkless commutation at all loads in either direction of rotation.

The problem in mechanical coal mining is to transmit or deliver to the face of the work the motive power needed for operation of machines at that point. It is customary to carry power-house voltage from 10 to 25 per cent. higher than the voltage rating of the machines to be operated. A well-designed motor will operate with good results with a voltage 15 per cent. in arrears or 25 per cent. in excess of the rated voltage for which it was designed. It is, therefore, consistent with good practice to maintain a voltage at all times within these limits.

It costs less to buy sufficient material to construct a thousand feet of No. 2 feeder line and return circuit and put this material in place, than the average cost of repairing one burned-out armature in a mining machine motor.

The great difficulty when supplying any kind of power to the face of mine workings is that some stretch

of the transmission is not sufficient. A thousand-foot 4-inch extension on a 1¼-inch air line, or a thousand-foot 4/0 extension on the end of a No. 2 copper wire will not produce quite as much pressure at the face of the work as there is at the point of junction, but this is only a slightly exaggerated example of some of the malpractice under ground today. In electric transmission the return is equal in importance to the live part of the circuit, and the same rule as to the consistency in connecting the circuit maintains. The temporary manner in which new operations are provided for power transmission is often the cause for hanging small wire, and the expense of replacing this later often delays the work, even indefinitely.

Another feature of transmission of power to the face of the work is the transmitting of two different varieties of power within the mine in order to have available the power suited to the best kind of motor possible for the different machines. For most all mining machines the three-phase alternating-current motor is much the best type manufactured, while for haulage the direct-current motor is preferable. It is not practical to operate a haulage motor on a three-phase circuit. It would necessitate three overhead bare copper wires with a difference between potential of each wire and a difference between potential of each wire and the ground, or an unbalanced circuit if one phase were connected to the track. It would cost nearly twice as much for such construction and would take more head room for the wire so hung. It would also necessitate either placing one or two of the wires out over the track or so low that men and animals would be more apt to come in contact with them. It is also rather impracticable to operate a locomotive on single-phase alternating current, because the voltage loss due to inductance of line must be added to the loss due to resistance in line.

Coal is mined by various machines, the most important of which is the chain machine, inasmuch as it produces more coal than any other mechanical means used. The chain mining machine is operated to some extent with compressed air, but more widely through the medium of electric power. The motor used on these machines is subjected to extremely irregular service. The machine is designed for a regular chain speed and regular mechanical feed, by which means man has made the best provision in his power to make the conditions for the motor favorable. The natural conditions under which the machine must operate all seem to impose hardships which are particularly effective on the motor. In practically all districts the frame of the undercutting machine is subjected to distorting strains from the squeezing of roof and pavement or from foreign substances in the bed of coal or slate being cut, or from irregularities in the slope or gradient of the seam. A binding frame loads the motor without the work of cutting coal. A motor does not lay down under slight overload as a steam engine, but stands the abuse until the coils in overheating roast and harden the insulation and finally a short circuit results, and we say the motor is burned out.

Of the alternating-current motors only the squirrel-cage type of induction motor is practical as far as the operation of the machine is concerned. In fact this particular motor is better suited for this class of work than any other design, due to the absence of all movable contacts and the extreme rigidity of construction in the rotating element. As an instance of the adaptability of this motor for severe service, and particularly for service in damp mines, we might cite the following case: It is recorded that motors of this class have given excellent service after having been submerged in water for several days, the only necessary repairs before starting up consisting in a partial drying of the windings. The principal objection to this motor for this service is the cost of construction of plant installation and transmission, which would necessitate a separate circuit for mining machines and locomotives; this, of course, is presuming that electric power is used for both purposes under ground.

Of the direct-current motors only the shunt, or compound-wound, types are practical for mining machine duty. The compound winding provides for more of an overload than the shunt winding, but it does not add to the rated horsepower of the motor.

The nature of the service of punching machine motors is such that a compact, sturdy motor is necessary. The jar on the motor connected end of the piston due to the blow struck on each stroke is only partly offset by the air cushion between the two pistons. The horsepower requirements of this motor are small, which necessarily produces a more delicate structure for the motor. In the past the tendency has been to sacrifice motor sturdiness in favor of light weight for the machine, and there has resulted considerable motor trouble from this class of machinery. The squirrel-cage type of alternating-current induction motor and the shunt and compound-wound direct-current motors are practical for this service.

For locomotive haulage it is necessary to provide either a storage for power or a transmission circuit of sufficient capacity to provide for peak loads on the motor at any point of the service. In mine haulage there is always a fixed minimum load on the motor which condition makes it possible to use a series-wound motor, either alternating or direct current. Heavy starting torque at low speed is also desirable and is one of the features of a series-wound motor.

The voltage loss in single-phase alternating-current transmission is such a consideration that this motor is not deemed practicable for mine haulage. The simple single-phase motor without the split-phase connections is not capable of producing a heavy starting torque, which is another disadvantage for this

service. The direct-current straight series-wound motor is, therefore, the practical motor for this equipment. The interpole feature would not add to the adaptability of this motor, because of the small horsepower and slow speed found in most of the locomotive equipment.

For continuous chain, or rope, car haul, the shunt-wound interpole direct-current motor is satisfactory, while if located outside the mine an induction motor makes a very satisfactory drive if an alternating-current circuit is available.

For hoisting, a large starting torque and good speed regulation are two requirements for the motor. For large underground hoisting installations the wound-rotor type of alternating-current induction motor with variable speed is giving excellent service, power being carried to the motor at high voltage over the surface to a bore hole at the site of the hoist and down the bore hole in lead-encased cable. This method of connecting and operating a large hoisting installation is particularly advantageous if the installation is some distance from the power house. For the small portable hoists the direct-current series-wound motor with suitable control, or the squirrel-cage induction type alternating-current motor, is best adapted. Constant speed is not required for this class of work and the motor best suited to starting under heavy torque is well adapted to this class of work.

Coal preparation takes place generally near the source of mine power and the motors are not affected by variations in voltage excepting as the overload on the plant so affects it. It can scarcely be said yet that it is the exception to find voltage in the power plants proper dropping more than 15 per cent. below rated voltage, but the up-to-date plants are designed with this particular provision in mind.

There is one important consideration in selecting motors to be used in connection with the preparation of coal. Such motors are always located in very dusty, dirty places, and if possible they should be motors without sliding contacts. It is useless to try to keep dust away from tipple motors, and the wear on brushes and commutator on direct-current motors is excessive and the sparking is unusually heavy. The squirrel-cage, or wound rotor, alternating-current induction motor is very suitable for this class of work if alternating current is available.

While not directly connected with the production of coal, the mine fan is the most important auxiliary feature to be considered. The safety of the men employed underground is dependent on the proper continuous operation of the mine fan. A fan load may be considered generally as uniform and the speed constant. Where conditions are favorable to the use of motor drive for fans, the most reliable power circuit and motor possible should be used. There should be an independent circuit from the source of power to the motor used for operating the fan, in order that short circuits on any other line will not affect its operation. Where it is not desirable to vary the speed of the fan, the squirrel-cage induction type of alternating-current motor is best suited to the work. If it is thought desirable to have a speed variation in order to operate more economically at night time or on holidays, the wound-rotor type of alternating-current induction motor would be a very suitable drive. If alternating current is not available, a shunt or compound-wound direct-current motor would operate satisfactorily, excepting that speed variation would be obtained only within very small limits and such variation would not provide an economical use of power.

It is considered good practice today to so ditch the underground workings that water may be drained to as few pumping sumps as possible. This generally necessitates a large pump located at a considerable distance from the source of power. For such an installation an overland, three-phase, alternating-current circuit at high tension, taken down the bore hole through lead-encased cable to the pump motor, is considered the most desirable means of providing power. In this case the squirrel-cage type of induction motor would be most suitable for the operation.

Because of the initial cost of both pump and motor and the proven satisfactory service given, high-speed centrifugal pumps are gaining in favor throughout the country for this service. The large reciprocating pump underground means an enormous chamber which usually must be arched and supported with steel. It also means transporting the pump to its location piece by piece, and making the best fit possible with the pieces after they have reached their destination. It also means slow operating speed with a comparatively slow-speed motor connected through a train of gears to the pump crank-shaft. The innumerable repair parts in the large reciprocating pump and the comparatively great surface exposed to the action of mine water, are facts tending to condemn this type.

If alternating current is not available, the shunt or compound-wound direct-current motors are suitable for this service. In this event if the pump be located more than a mile from the source of power, the mine voltage being 250, it would be advantageous to install a separate generating unit for pump-motor drive and carry the transmission lines overland to a bore hole, whether the circuit be 500 volts direct-current or a higher voltage alternating current.

All shop drives impose a more or less variable load on motors, which would eliminate both the alternating-current and direct-current series-wound motors for this service. As in the case with motors used in connection with coal preparation, it would be advisable to have all electric shop drives on an alternating-current circuit independent of mine operation, in which case the squirrel-cage induction motor would be best suited for the work. If alternating current is not available, the shunt, or compound-wound, motors would be satisfactory, and we would rec-

ommend the interpole motors where horsepower does not exceed 15. The motors recommended would produce practically constant speed under any load variation within the limits of the capacity of the motor.

For deep-well pumps or river pumps, where the motor can be safely located above high-water mark, it is only important that a constant-speed motor be used. It would, however, be most consistent with the economical operation of a plant to use the alternating-current induction motor if such power is available. A shunt-wound motor would be suitable for direct-current operation with interpole feature if the motor is within the limitations for such. Where high water is liable to make it necessary to move the pumping equipment it would be advisable to use a light high-speed motor of same type as mentioned above.

Coke larry motors may be operated with alternating-current, single-phase, series-wound motors or direct-current series-wound motors, whichever may be most convenient.

The outside lighting circuit should be independently connected to the power station switchboard, in order that it may not be affected by short circuits or grounds on other lines, and also in order that a similar accident on the lighting circuit will not affect the other operations. Shaft or slope lights should be connected on an independent circuit also. Alternating-current transmission with step-down transformers with 110 volts secondary is best adapted to incandescent lighting systems.

We have avoided the comparison of electric power with other powers used in mine service in order to keep within the limits of the assigned subject. There are some important advantages in the use of electric power which might be touched upon briefly.

The most important advantage lies in the fact that the transmission of electric power can be accomplished with the cheapest construction for such transmission of power economically in unlimited quantities and at unlimited distances with a minimum loss in transmission. This emphasizes another point mentioned previously in this paper, that the most important feature of mechanically operated mines, lies in getting the power to the face of the work or to points where it is used.

Economical operation of power plants must be considered for a full 24-hour-day's run, if power is needed at all times during the 24 hours. Electric power units are operated more economically on light loads than any other generators of power in use today. This provides a minimum loss at power plant when power is not being used or when it is being used for light loads only. The dispatch with which electric circuits can be carried to points where the power is to be applied is an advantage in electric transmission. The ease of control of electrically operated apparatus and the efficiency of such apparatus under control is also an important feature. For mine haulage a constant supply of power is to be had without delays necessary when storage tanks are charged. The few repair parts necessary for electric motors makes a comparatively cheap maintenance possible. The practicability and general use of central power stations and high-voltage transmission has provided for a minimum excess of peak loads over the average load.

Pittsburg Meeting of A. I. M. E.

In Pittsburg alone there are approximately 80 members of the Institute, presumably 30 of these are coal miners, and when the surrounding coal fields are canvassed it is probable that 30 more members would be found, yet there was but one paper having direct bearing on the Pittsburg coal district, at the recent meeting. This was a disappointment to the visitors interested in coal and coke, and wondered at, because the enormous industry of western Pennsylvania produced 173,781,217 tons of bituminous coal in 1913, and the operators and engineers of the Pennsylvania bituminous coal district are, to put it mildly, almost proud of their coal mining achievements.

While Mr. H. A. Kuhn's paper was interesting, it was too generally descriptive to be of much value to those seeking information on the methods of working which possibly they could employ in their fields, or at least discuss how they accomplished similar work, which would be of advantage to the industry everywhere.

The rule-of-thumb mining has prevailed in the bituminous coal fields as largely as in the anthracite, and it is only in recent years that technical men have been able to put advanced ideas in practice; and since most of those ideas trend toward the conservation of coal, as well as economy, it is very important to the coal mining section of the institute that they be explained and commented on.

George S. Rice, mining engineer for the Bureau of Mines, gave an interesting illustrated lecture on the "Investigations of Coal Dust Explosions and the Rice Barriers." On Friday an excursion was made to the Bruceton experimental mine, where a practical demonstration of both the Rice and Taffnel dust barriers was given. A practical demonstration was given of the "cement gun" in covering with a layer of cement some boards set to represent an air stop in the mine. This gun will be valuable to those who wish to make tight air stops and joints about doors. The gun also has been used recently in mines to repair breaks in concrete lining, and in this respect it has been so useful at Bruceton it was given a demonstration. A report on the Rice and Taffnel dust barriers will appear in a subsequent issue of this journal.

Mr. J. W. Paul, of the Bureau of Mines, explained some moving pictures to show how miners did their work. The subject was "Safety Methods in Mining." One of the three reels showed a miner with an open light in his cap handling a

powder keg. It was so natural we started to run, but remembered where we were in time. Another scene was where a fire boss entered a room with an open light on his head and a safety lamp in his hand to test for gas.

Mr. J. P. K. Miller had a paper on the "Manufacture of Coke," but he merely read extracts from it. After he sat down, Mr. I. C. White asked if there had been any attempt made in this country to manufacture coal tar dyes. Mr. W. H. Blauvelt, who has been in the by-product oven business many years, replied that he knew of no reason why chemical manufacturers had not reached after the business except that they had hardly got started, but no doubt would do so in time.

Most of the information given in G. S. Rice and H. H. Clark's paper on "Shot Firing in Coal Mines by Electric Circuit From the Surface" appeared in Mines and Minerals in articles written by men who made use of it, therefore those who contemplate its use are referred to the following articles:

"Shot Firing by Electricity," by D. Harrington, Vol. 29, p. 38, August, 1908, with discussion on pages 174 and 216; "Prevention of Coal Mine Accidents," by E. C. Coxe, E. M., Vol. 30, p. 309, December, 1909; "Utah Fuel Co.'s Firing Rules," by A. C. Watts, chief engineer, Vol. 30, p. 591, May, 1910.

Dr. H. M. Chance not being present, his paper was read by title and commented on by Mr. R. Van A. Norris, whose preference is for a system of taxation based on output. We agree with Mr. Norris, so far as working operations are concerned, but so long as the land is kept fallow there should be a tax based on its unproductive value as well. This naturally will increase as railroads make unimproved coal lands available and the output tax will be cumulative so to speak, for it will be more than the output tax of today. It is claimed that foreign coal land owners have large investments in coal lands in this country that they do not develop, but hold for an increase in value. We can see no objection to this and certainly no community is the loser provided taxes are levied on the increased value of the land. As an illustration, suppose a certain district in West Virginia has available 100,000 acres of coal land along a railroad, and some one holds 10,000 acres, and pays one-tenth the taxes. Again suppose 10,000 acres of coal are mined from the 100,000 there will be 90,000 left and the man holding the 10,000 must pay one-ninth the total taxes which will probably never grow less than the original assessment. With this cumulative tax we cannot understand how any one but the land holder is loser, for by the time the 90,000 tons are mined he is paying taxes on $1,500,000 if the original land cost $15 per acre, and furthermore no one will probably pay him $150 per acre when coal land can be had in some other locality for very much less because of the increased tonnage tax and high land tax.

Mr. William Griffith stated that it was not safe for an expert to declare on what he based his valuation in the anthracite fields. The conditions surrounding anthracite mining are peculiarly bad for the consumers. Land originally was cheap, but as the population increased and towns grew into cities the coal companies owning surface land could not afford to pay the taxes on their valuation and therefore sold the surface rights.

The surface land outside of cities has increased proportionally in value and taxes have been raised naturally. Under present conditions operators are taxed for surface land, surface improvements, coal in the ground, and a tonnage tax on coal shipped. If they store coal in New Jersey for winter distribution, they are taxed for surface land and improvements and on the value of the coal stored. Of course interest on investments, all taxes and some profit must be had by increasing the price to the consumer. As the very same conditions must apply in other coal fields, there should be no objections to any one holding coal lands for an increased price, in other words speculation provided taxation is equitably adjusted.

Mr. H. N. Evenson presented a paper containing a list of the gas and dust explosions that have occurred in coal mines, and is the most complete probably on record. If one could take the list and comment on each disaster giving the cause, it would prove a great "safety-first" article provided men in charge of mines would try to avoid the mistakes made by others. Any one can obtain this paper or any other of the papers here mentioned for 10 cents, by addressing Bradley Stoughton, Secretary, A. I. M. E., 29 W. 39th Street, New York City.

Friday afternoon was devoted to excursions, and Friday evening to a banquet. The papers read Saturday morning dealt with electricity and miscellaneous mining subjects. S. S. Rumsey and W. F. Schwedes prepared a paper on "A Test of Centrifugal Motor-Driven Mine Pumps." O. P. Hood had a paper on "Gasoline Locomotives in Relation to the Health of Miners." G. S. Rice and H. H. Clark, "Shot Firing in Coal Mines by Electric Circuit From the Surface." There was a general discussion on the "Use of Electricity in Mines," which was led by William Kelley.

Saturday afternoon the members left for their homes, with the exception of those who took occasion to visit the Bureau of Mines experimental station.

Correction

The article entitled "How Mining Engineering Eliminates Accidents," which appeared in the November issue, was written by H. W. Saunders, division engineer, and not by Mr. Booth. Mr. Saunders and Mr. Booth both contributed papers at the Safety Boosting Banquet, at Gary, which were published in the same issue, and through an unfortunate mix-up the authorship of the above-named paper was wrongly given.

Improvements in Beehive Ovens

The McMurray Coke Oven Door—Campbell's Plastic Door Clay—The Stauft Door Remover—The Stauft Coke Extractor

Abstracted from The Connellsville Courier

Among the many interesting improvements in the equipment of beehive and rectangular coke ovens that have been developed during the past few years are the McMurray door, the Stauft coke extractor, and Campbell's plastic clay for filling and daubing coke-oven doors. A number of different kinds of coke-oven doors have been developed, of which the leading ones are the Mitchell-McCreery, McMurray, Knopf, Peters, Humphries, Hay-Rule.

It has been customary to line all of these doors except the McMurray door with firebrick of special shapes.

The door, developed by William McMurray, superintendent of the Mount Pleasant Coke Co., is of solid cast iron with finger-like projections on the inside, which serve as retaining points for a fireclay daubing mixture.

Fig. 1 shows the inside of the McMurray door. The projections are cast with an upward angle, but a modification of the idea consists in making use of the rivets which can be renewed if they are broken or burnt off.

Fig. 2 shows the door in place on a machine front, arranged for mechanical handling. The McMurray door for rectangular ovens is in four sections on account of the size and weight. Hinges are set in the jambs and side walls, but there are other methods that might be adopted. The door for hand and machine beehive ovens is in two sections with the top one dropping back on a hinge to permit leveling. Doors for machine leveling through the trunnel may be cast in one piece.

Fig. 1. Inside of McMurray Door

The McMurray door for machine beehive ovens weighs between 500 and 600 pounds with the lining. It can be installed for from \$15 to \$18 complete with trolley arrangement for handling. The H. C. Frick Coke Co. has about one dozen of these doors with the trolley system of handling at its Lemont No. 2 works, and the results are very encouraging.

In developing the McMurray door, it was soon discovered that the usual mortar made on the coke yard from loam, clay, and ground brick bats, give only a few months of service on account of its cracking and falling off the iron frame. J. R. Campbell, chief chemist for the H. C. Frick Coke Co., became interested in the matter of a suitable lining for D. B. Stauft who was desirous of securing a trial of the McMurray door with a better daubing material. Mr. Campbell, after experimenting, developed a plastic clay daubing mixture which seems to have solved the problem for a door of this kind. On account of the materials going into this daubing mixture and the careful preparation that is necessary, he thought it should be made at the brick yards and not at the coke-oven plant, where there are usually no facilities for such work.

The mixture is, therefore, shipped in the plastic and tempered state ready to be applied to the door. In case storage of this material is necessary on the plant for minor repairs, all that is needed is to bury it in a pit and keep it damp. It should be sprinkled occasionally with water and kept covered with a wet brattice cloth or something similar. It must be carefully tamped in the frame of the door and if possible, the door should be allowed to dry out before being placed in service. However, if ordinary precaution is used, it may be swung in place while "green."

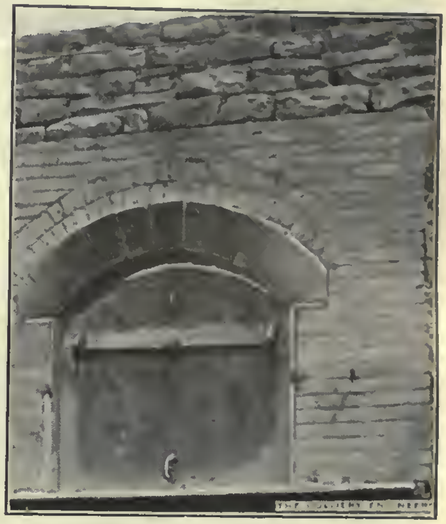


Fig. 2. The McMurray Door in Place

The heat from the oven burns the mixture into a solid brick without cracking and a glaze appears on the inside which resists wear.

So far, no doors have actually been lost through failure of the daubing from a refractory standpoint, nor has it failed to stick to the projections on the McMurray door. Careless handling or dropping a door on the yard has sometimes knocked out a piece of the lining here and there, but it may be repaired in a few minutes.

This mixture is adaptable to other mechanical doors after a few retaining points are provided. It has been used on the Humphries door, is much cheaper than a tile lining, and makes a good lining for by-product coke oven doors. It can also be used around open-hearth furnaces and boiler furnaces where considerable difficulty is experienced in using firebrick linings.

Fig. 3 illustrates the old and new way of sealing beehive-oven doors.

The Campbell mixture is manufactured and sold by the Harbison-Walker Refractories Co., of Pittsburg.

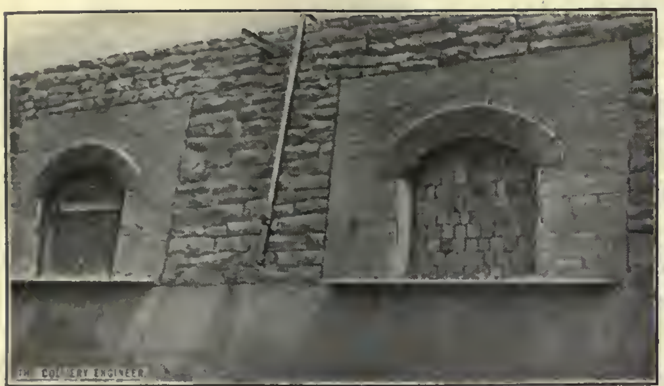


Fig. 3. The Old and New Way of Sealing Beehive Oven Doors

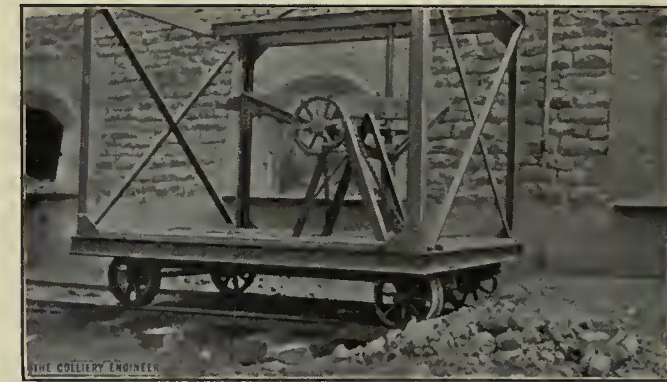


Fig. 4. The Stauft Door Extractor

About 200 pounds of Campbell's plastic clay is necessary to line a McMurray door, which amounts to about $1 per door, exclusive of freight and labor of handling and tamping it in the door. Including freight and labor, the lining should not exceed $1.25 per oven.

Experience shows that a lining will last 1 year and it is expected that it will last 2 or 3 years with fair handling, and a few occasional minor repairs. On this basis, the cost of the clay lining per oven per day is almost negligible, amounting to a mill or two.

Brick, blocks, or tile for coke oven doors range in cost as follows: Rectangular ovens, $5 per door or $10 per oven; machine beehive ovens, $3.50 per door; hand beehive ovens, $2.75 per door; all exclusive of cost of labor for installation. In point of service, the tile may sometimes last as long as the Campbell clay mixture, but its up-keep and repairs are more extensive.

Another advantage of the Campbell plastic clay in doors is that it prevents air leaks through the door. The increased percentage of yield of coke by using doors that are free from air leaks is quite an item of saving. It prevents waste at the door and the coke is of full height. An increased yield of 1 per cent., which is more than possible by use of an air-tight door, means 10 cents per oven, with coke at $2 per ton.

The Stauft door extractor, used by the Taylor Coal and Coke Co. to remove the McMurray door, is shown in Fig. 4. This machine is the invention of D. B. Stauft, general manager of the Taylor Coal and Coke Co., Uniontown, Pa.

The door extractor is simply a jack on a truck, which runs ahead of the coke machine, swings out the door for inspection, and then places it on the supports at either side of the oven-door jambs.

Another mechanical appliance developed by Mr. Stauft, is his coke extractor, which is shown in Fig. 5. These improvements indicate that it is necessary for the beehive-coke oven operators to adopt mechanical and labor-saving devices to enable them to compete with the by-product coke ovens, which now produce one-third of the coke made in the United States and are gaining in percentage each year.

We are indebted to Mr. R. H. Youngman, of the Harbison-Walker Co., for the illustrations in the article.

Fig. 5. Stauft Coke Extractor

Sirocco Fan Duty

The Pennsylvania Railway tunnel, at Baltimore, is 4,963 feet long, with a cross-sectional area of 432 square feet. It is ventilated by two Sirocco fans 12½ feet in diameter and 18 feet long. The tunnel requires 450,000 cubic feet of air per minute and the fan changes the air in the tunnel once in about 4¾ minutes.

One fan deals with this quantity of air which weighs 16¾ tons or about as much as 5,000 bricks or 170 barrels of water holding 4½ cubic feet. It would require 107,000 barrels to hold the air delivered by the fan every minute. If these barrels were stood on end they would occupy a space 600 ft. × 600 ft., an area that is equal to about two city blocks. To discharge the air and overcome frictional resistance of the tunnel, the fan must make 104 revolutions per minute, which gives a speed at its circumference of 46½ miles per hour and requires 190 horsepower.

A School of Mines

In South Wales—Supported Solely by the Colliery Proprietors of the South Wales and Monmouthshire Coal Fields

By Our British Correspondent

IN VIEW of the interest which has been taken in the education of the men who will later have to occupy responsible positions in the coal fields of the world, it will be interesting to refer to an institution which has been recently founded and which is supported and maintained solely at the expense of the colliery proprietors of the South Wales and Monmouthshire coal field. For many years the coal owners were desirous of improving the technological and practical instruction in the science of coal mining in all its branches, for the purposes of their business. As a result, a number of coal owners in the district formed a mining board for the coal field mentioned for the purpose of establishing schools of mines in South Wales and Monmouthshire. The new School of Mines, at Treforest, is the first instalment of their scheme, and will no doubt form their central institution. This school of mines has been provided with modern laboratories and equipment, and a similar course will be adopted at other schools in the coal field, for the purpose of affording similar facilities for those for whom the central institution is not readily available.

Chemical Laboratory, South Wales School of Mines

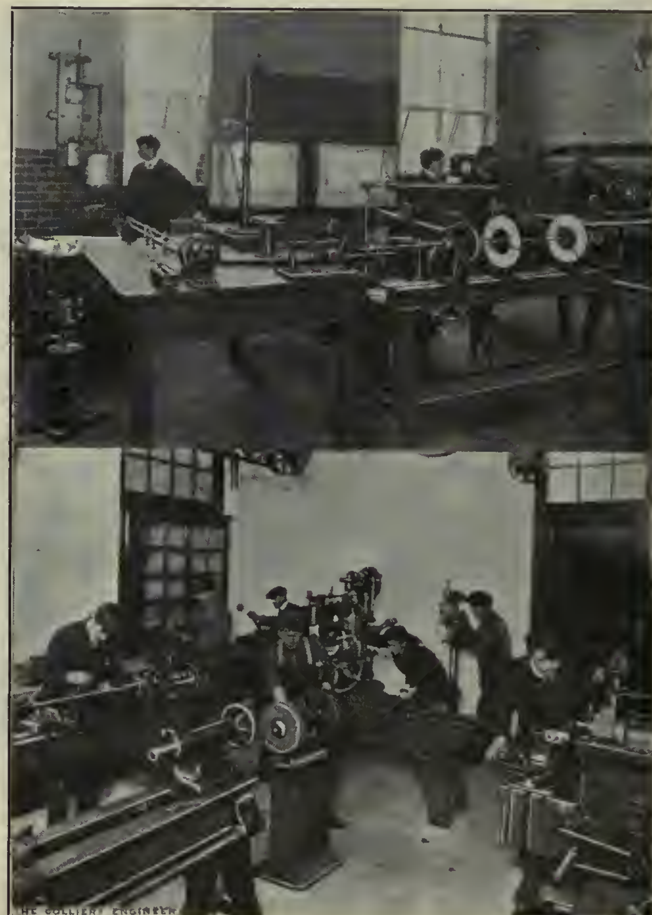
The intention is that the students shall receive by means of the laboratory equipment, technical and practical training and experience in the matters with which they will subsequently have to deal as colliery officers, and an important part of the scheme is that arrangements have been made whereby the students are afforded opportunities of visiting, under the control of the staff, the different collieries of the associated coal owners and handling under working conditions, the machinery and plant with which they will subsequently have to deal. As the work of the school is directly associated with a large number of collieries in the immediate neighborhood, exceptional facilities are afforded to students for studying the most modern methods of colliery practice at first hand. The students have the privilege of seeing tests made under actual working conditions, and, generally speaking, the work at the school is looked upon as an integral part of actual colliery management. This gives the students an unrivaled opportunity of getting a good technical education while keeping in touch with actual working conditions. Moreover, the school is open to all students on equal terms subject to passing the entrance examination or an equivalent test.

The expense of the scheme is borne by the coal owners by means of a tonnage levy of one-tenth of a penny on their declared output for the previous year. The institution at its start is supported by associated companies having a total output of approximately 20,000,000 tons. The University College of

South Wales and Monmouthshire is at Cardiff, closely adjacent, and in order to prevent any overlapping in instruction, a joint working scheme has been arranged. The 3 years' diploma course in mining hitherto carried out at the University College, Cardiff, is discontinued, and instead a joint diploma is given by both institutions, the University College, at Cardiff, giving that part of the joint instruction comprising pure science, while the School of Mines attends to that part dealing with the technical application of the science to coal mining. A fourth year, or post diploma, course is also put into operation by the college for those promising students who wish to specialize scientifically in any one or more subjects. The joint authorities also award certificates to mine surveyors who require recognition under the British Coal Mines Acts. The mining board is the governing body of the School of Mines, and is composed of two representatives from each constituent company. Sir Clifford J. Cory, Bart., and member of Parliament, is the first chairman of the board, which comprises most of the principal colliery proprietors in South Wales. The legal constitution of the School of Mines is under a deed of trust.

In addition to the usual lecture and drawing rooms there are gas testing, geological, physical, chemical, heat, and mechanical laboratories, also electrical and mechanical workshops equipped with modern machinery for practical tests. These include lathes, drilling machines, smithy, steam testing plant, an experimental winding engine, a gas producer, gas engine, water turbine and generator, electric motors, a 150-ton testing machine and other appliances. The principal and director of mining is Prof. George Knox, Fellow of the Geographical Society, to whom we are indebted for the information herein contained. It would be tedious to detail the courses which are given. Generally speaking, however, in addition to a full time day mining course, there are special courses for mine mechanics, electricians, chemists, and surveyors, while there is also a course for colliery surface foremen, and special courses for colliery managers, surveyors, etc. Among the subjects treated are chemistry, particularly that of fuels, colliery practice, colliery engineering, design of machinery, electrical physics, and electrotechnics, engineering, mining mathematics, geology, mechanics and heat engines, methods of working, mineralogy and mining chemistry, physics, mining valuation and mining law. The illustrations show respectively

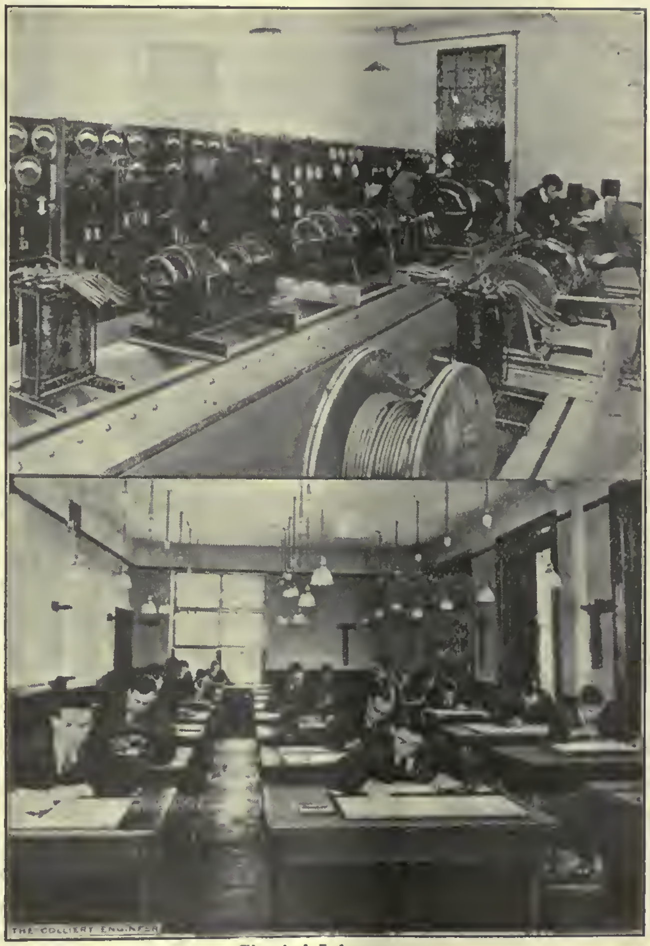
Physical Laboratory
Gas Laboratory
South Wales School of Mines



Mechanical Laboratory
Machine Shop
South Wales School of Mines

the chemical laboratory, the physics laboratory, the mining laboratory, the engineering drawing room, the electrical engineering laboratory, the mechanics laboratory, and part of the mechanical workshop. In addition to the work at the college itself, part of the instruction consists in visits to the collieries during the session, while students having a full-time mining course have to obtain at least 4 months practical experience in the mine during each summer. Facilities are provided for this by the mining board at one of the subscribing collieries in cases where students are not in a position to provide such experience for themselves. The part-time courses are arranged for students employed in or about collieries, who cannot afford to give up their work entirely during a protracted course of study. At the end of the session, visits of inspection are arranged to other British or Continental coal fields under the guidance of members of the staff, the students furnishing a detailed report of the mines and other works visited as part of their class work.

It is not often that it is possible to record such a thorough and systematic attempt to equip colliery men with the highest possible means of technical education apertaining to their industry with the minimum of expense and inconvenience. The situation of the School of Mines is in the center of one of the world's most important coal mining areas, and with the establishment of further schools of this nature, it will be seen that probably one of the completest and most progressive attempts at the technical education of colliery workers that has ever been attempted will have been successfully accomplished.



Electrical Laboratory ,
Drawing Room
South Wales School of Mines

Pyrite in Coal Measures

The coal beds on the property of the Stearns Coal and Lumber Co. are in the Lee conglomerate, corresponding to the Pottsville conglomerate. Here the Lee conglomerate approximates more nearly the Pottsville with its rounded quartz pebbles in the anthracite fields of northeastern Pennsylvania than any coal formation conglomerate the writer has seen. The coal is bituminous, and in places cannel and soft coal are found in the same bed. Above the No. 2 coal bed there is a black band carbonate of iron from 12 to 16 inches thick, which occurs as draw slate and is shipped to La Follette, Tenn. Analysis of the roasted ore shows it to contain 61.6 per cent. iron with a total phosphorus content of .05. As the ore is brittle it makes a poor roof and usually falls as soon as the coal is mined.

Several hundred feet above this deposit there is a bed of massive pyrite 6 feet thick, which is also an unusual feature in the coal formations and so far as the writer knows is not duplicated in other coal fields, although pyrite galore is found above or underneath some coal beds, as well as in cleavage planes in some coals.

There are black band ores in West Virginia, Ohio, and Pennsylvania, but so far as known they do not occur in direct contact with the coal, nor are they worked at this time, although in Ohio they were once used for Scotch pig iron as the product was called.

Dr. I. C. White relates that a furnace was built some years ago to smelt this kind of ore in West Virginia, but as the ore petered out it never went into blast. From the point of conservation as well as a business proposition, coal mine operators should examine their lands for black ore. They cannot well be misled, as it is too heavy and differs in appearance from slate, leaves a dark brown powder when scratched with a knife, and effervesces when a drop of acid is placed on it. The Stearns black-band ore contains only a trace of sulphur, 1.8 per cent. silica when roasted and 8.3 per cent. of magnesium and calcium oxides.

Gary, Ind., although Indiana produces no coking coal, has the largest by-product oven plant in the world. It consists of 560 Koppers ovens using 9,500 tons of coal daily, which produce 8,000 tons of coke, and furnish 95,000,000 cubic feet of gas, 50 per cent. of which is used in the steel mills and 50 per cent. in heating the ovens.

English Coal Washing Plant

A Description of the Arrangement of Apparatus and Method of Operation of a Plant at Barugh, England

IN A recent issue of the *Colliery Guardian* a detailed description was given of a new coal washery erected by the Old Silkstone Collieries, Ltd., at Barugh, near Barnsley, England. It is a substantial ferroconcrete building housing equipment designed to handle 1,200 tons of coal in a 10-hour day.

The screenings are delivered to the plant in cars which run by gravity over the scales to the elevator pit, *A*, where they are automatically dumped. From the pit the coal passes through an adjustable slide into the bucket of the main elevator *2*. The latter raises the coal to the classifying screen *3*, provided with ½-inch mesh. This classifies the coal into two sizes, between ½ inch and 2½ inches and below ½ inch. The latter then passes into a dust extractor *6* operating as follows: The coal drops into a pocket and by means of a rotating cylinder *7* is conducted uniformly past a suction nozzle which draws off the coal dust by means of a vacuum produced by the fan *9*. The coal now free from dust is delivered into the washer *11* through the water spout *10*. The dust having been drawn off settles to the bottom of the dust extractor and is then fed through spout *12* on to conveyer *13* and thence into screen conveyer *14* where it mixes with the washed fine coal prior to crushing.

The coking coal after passing through the washer *11* is run through the water spout *33* into sump *B* from which place it is drained by two elevators *34*, provided with hinged buckets. The elevators deliver the coal to chutes *35* whence it passes to two conveyers *36*, which distribute it into the various pockets *F* of the 1,000-ton storage bunker. Rotating feeding tables *37*, provided with regulating slides, draw the coal from the bunker and discharge it on to two belt conveyers *38*, which lead to the screw conveyer *14*. The latter delivers the dust as well as this coal into chute *39* and thence to the disintegrators *40*, where the crushing takes place. The crushed coal falls into a pit *G*, from which place it is fed through an adjustable opening *41*, into buckets of the elevator *42*, which delivers it by way of chute *43* and conveyer *44* into the coking coal hopper *H*. From this hopper the coal runs through chutes into the compressing box of a combined coal charging and coke pushing machine *46*, where it is compressed to a solid cake prior to charging into the ovens. Two compressors travel on tracks on each side of the hopper; they are electrically driven and automatic as well, traveling to and fro and stamping the coal at the same time.

Provision is also made for drawing the coal from the hopper *H* by way of spouts *60* and for charging the ovens from the top by means of larries.

Returning to the treatment of that coal above ½ inch in size, it is passed from screen *3* into a water chute *4* and on to a washer *5*, where it is cleaned and then carried by way of a water chute *15* to a double classifying screen *16*. The top screen drains off the water which runs by way of chutes *17* and *33* to the sump *B*. The lower screen classifies the coal into three sizes owing to the two different meshes, ¾ inch and 1½ inches, in the screen. The coal then passes through the spiral chutes *18* into the hoppers *C*, whence it is loaded into railroad cars by means of the chutes *19*.

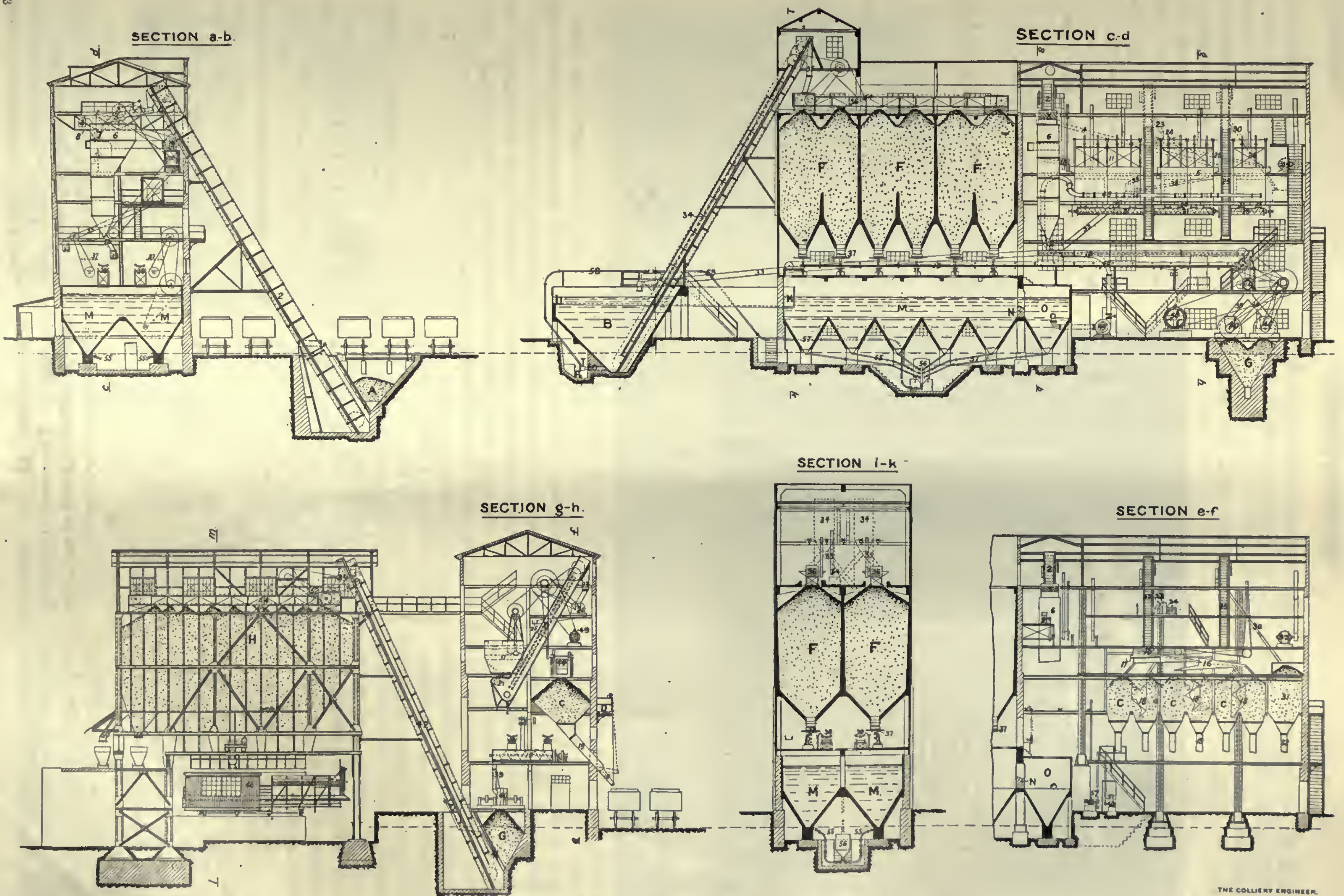
The shale and other impurities separated by the two washers *5* and *11* are periodically discharged through the valves *20* into the two screw conveyers *21* and delivered to the crushers *24* by means of the elevator *22* and chute *23*. Here the shale is crushed to separate any clinging pieces of coal, which is then recovered by rewashing. To this end, the product of the crushers is fed through the water chute *25* to the washer *26*, the coal recovered overflows into the water chute *33* and passes to the sump *B*.

The shale now freed of all practically recoverable coal, is periodically discharged through valves *27* into the screw conveyer *28*, thence into elevator *29*, raised to the chute *30*, through which it passes to the shale hopper *31*, from which it is loaded at will through chute *32* into cars for dumping.

The water for the plant is reused repeatedly. All losses due to evaporation, absorption, etc., are made good by the addition of fresh water when necessary. A centrifugal pump *47* directly connected to an electric motor takes clean water from the sump *O* and discharges it through the pipe *48* to the points desired.

During its contact with the coal the water becomes highly impregnated with fine coal dust which must be removed before using again. For this purpose the water is made to overflow from the sump *B* through the channels *I* and *K* into the settling sump *M*, which it traverses slowly, the clean water overflowing through the opening *N* into the sump *O*. During the progress of the water through *M*, the fine dust settles in the form of a sludge which is drained off through the pipes *51* and *55* into a steel tank *56*. Here a new agency is instituted and compressed air forces the sludge through the pipe line *57* into an intermediate tank discharging into the bucket elevators *34*. However, if at any time it is not desired to mix the sludge with the coking coal, it can be forced through the pipe *58* into the sump *P* which overflows to the culm piles situated in the fields below the washery.

The whole of the machinery is driven by six electric motors totalling 425 horsepower, although but 350 horsepower are required when working at full capacity. The wash-



Longitudinal and Cross Sections of Washery at Barugh, England

ery is of Meguire design as were also the coking coal bunkers and the combined coal charging and coke pushing machines.

Fig. 1. Systematic Timbering

Safety in Systematic Timbering

*By W. P. Kearns**

Probably no other one of the numerous items connected with mining is so conducive to safety and efficiency as timbering. Systematic timbering and proper attention to the details connected with its application will prevent accidents from roof falls, in addition to saving labor and extra timbers. To accomplish this in our mines, props are to be set close to the rib, 3 feet apart with 6-foot cap pieces extending over the road, and no posts are to be set out from the rib and between the rib and the track.

Gob posts are to be set from 4½ to 6 feet apart with 4-foot cap pieces parallel with the room length; this arrangement, however, will depend on the roof and the joint planes so that in some cases the cap pieces must be placed lengthwise of the room. See Figs. 1 and 2.

Where machines are used for undercutting the coal, props should be kept within 5½ or 6 feet of the face and in pick mining within 3 feet of the face.

Whenever props are stood along the room road, plenty of clearance for cars must be allowed, as many serious accidents have occurred by cars knocking out props and causing roof falls, and by men getting squeezed between the car and the prop. Two feet is none too much space in such cases, as shown in Fig. 1, although in double-room timbering, Fig. 2, but 18 inches is shown; however, even if particular attention is given to keeping the rib side clear, 2 feet is preferable and is allowed in this particular mine between the rail and the post on gob side of the track.

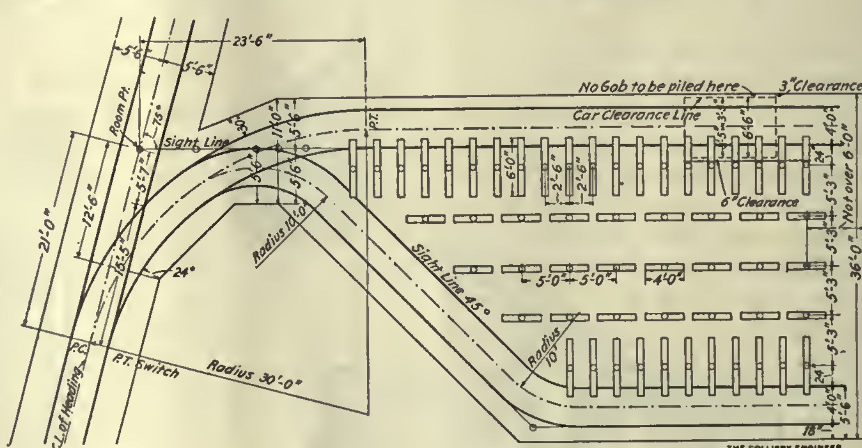


Fig. 2. Double Room Timbering

As falling top is the greatest source of danger in coal mines, the more attention given to holding it up by systematic timbering, the fewer accidents will happen. The "Safety-First" movement is one that is filled with human sympathy and brotherly love. It enobles and elevates both employer and workmen, and brings them into closer and better relationship.

*Abstracted from a paper read at the Boosters' Banquet United States Coal and Coke Co., Gary, W. Va., by the superintendent of Nos. 7 and 8 mines.

Berwind-White First-Aid Meet

Berwind-White Coal Mining Co.'s annual first-aid meet was held at Windber, Pa., October 31, in Recreation Hall.

The manager of events was Allan S. Snyder, the instructor in first-aid and mine rescue work; the official announcer was Dr. J. W. Hawes; and the official recorder, Jack H. Burt, The judges were Dr. E. P. Dickinson. St. Michael, Pa.; Dr. E. H. Lowe, Seanor, Pa.; Dr. A. Basil, Windber, Pa.; Gomer H. Phillips, Johnstown, Pa., instructor in first-aid and mine rescue work of the Cambria Steel Co.

RULES GOVERNING THE MEET

1. A first-aid team shall consist of six persons.

2. All types of dressings, bandages, splints, and stretchers, and all methods of application which conform to the standards of first-aid practice will receive equal credit.

3. In the "two-men and three-men" events the captain of the team

shall designate which of their number shall demonstrate these problems.

4. At the sound of the gong, patient will take position on the ground, feet toward spectators. Second gong, team will advance and treat injuries. Two gongs, take patient back to station and remove bandages.

5. The judges shall use the discount table as a guide in marking the work of the teams. They may discount a team from 1 per cent. to the limit allowed for penalties specified. The judges shall rotate after each event. After judges submit their discount sheet to the recorder, there shall be no changes made in their marking, and the recorder shall receive no report or discount except from the judges. There shall be no appeal from the decision of a judge.

6. The team making the highest average in the contest will be declared to be the winner. Should two or more teams be tied for highest honors, the judges shall select a problem which shall be used for demonstration by the teams tied to determine which shall be the winner.

7. A silver loving cup will be awarded to the team making the highest average, and the members of the team shall have their names engraved on said cup. When a team wins the cup two successive times (at annual meets) it becomes their absolute property.

8. The cup shall be in the care of the First-Aid Department until it becomes the absolute property of a team.

9. The winning team shall retain their title and claim to the cup as long as they maintain their organization as a team. Should any members of said team leave, the remaining members of the team shall have the privilege to substitute provided they retain at least three members of their original team.

Berwind-White Coal Mining Co. First-Aid Meet

One of the features of this meet was the absence of waste in the use of material. While there was a sufficient quantity of material, there was no unnecessary amount used.

Another feature was a departure from the old method of judging.

The system of judging in first-aid contests has been very much criticized and caused considerable dissatisfaction because of the fact that no two judges will penalize or discount alike.

In this meet, this objection was overcome by the following method, which met the hearty approval of all contesting teams, spectators, and all others concerned.

The judges watched the work of their respective teams to which they were assigned, and after the problem was completed, all the judges went over the entire work together and all concurred in the marking of each team. Each judge was assigned to a different team after each event, in other words rotated after each event. The result was that all persons concerned were satisfied that the marking was uniform.

It requires a little more time but it is worth taking a little more time to give satisfaction. There is no doubt but that meets of international importance can profit by adopting a similar method.

Team No. 3, Eureka No. 37 mine, made 100 per cent. and was awarded possession of the cup which will be contested for in 1915. This team, composed of John R. Swanson, captain, Bernard Smith, patient, James H. Lewis, Wm. H. Gearhart, Ralph D. Schaffer, and Walter E. Reichelt, will have their names engraved on the cup.

Team No. 6 from Eureka No. 39 mine made an average of 99 per cent., Team No. 7, Eureka No. 36 mine had an average of 98.8 per cent., while Team No. 1, Eureka No. 35 upper mine, made 97.8 per cent.

Seven teams were entered in this contest.

Great interest was shown by all present, and the entire contest was highly successful in all its features.

Mine Bulkheads

The Design, Construction, and Cost of Two Mine Bulkheads at Hibernia Mine, New Jersey

*By Staney L. Wise and Walter Strache**

WHILE the installation of mine bulkheads to retain water under high pressure is by no means a rarity, the following points which arose in the designing and placing of two of these bulkheads may be of interest:

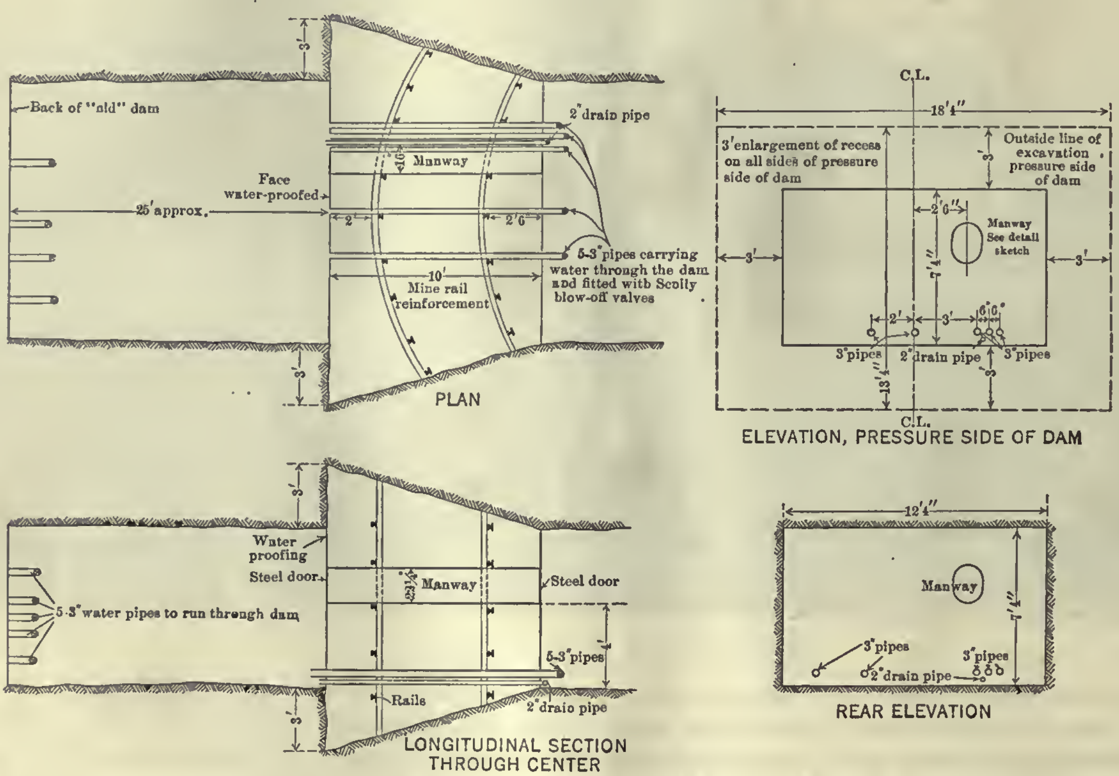


Fig. 1. Reinforced Concrete Bulkhead for 16th Level

The Hibernia magnetite mine, located about 40 miles west of New York, in the state of New Jersey, is partly filled with water. This mine is located on an ore lens, the outcrop of which is over a mile long. The ore has been mined from this lens from the surface to a depth of more than 1,500 feet. It was held desirable to separate the old workings from the new, and to allow the former to fill to the 850-foot level. Two weak places existed between the new and old workings below this level; namely, a temporary bulkhead on the 10th level and a rock bulkhead of indeterminate thickness on the 16th level. When the matter of allowing the old workings to fill was investigated, the fact was developed that if these old workings were filled, the bulkhead on the 10th level would be subjected to a water pressure of about 50 pounds per square inch, and that 200 pounds per square inch would act on the 16th-level bulkhead. As the barriers were not deemed of sufficient strength to permit of these pressures, it became necessary to design and install new bulkheads.

As the 16th-level bulkhead was required to withstand a pressure of 200 pounds per square inch, it presented some difficulties. A careful consideration of the various types of mine dams now in use led to the adoption of a design of the form of a truncated wedge. In this, the pressure side of the dam is of greater area than the back, so that the resultant action is similar to driving the wedge. By cutting generous skewbacks in the walls, roof, and floor, this form becomes an invisible arch while the wedge feature tends to compress the materials in the bulkhead, thereby adding to its imperviousness.

Concrete was chosen as the material for construction. In order to lessen the labor and simplify the construction of the forms, straight forms were placed on both the front and back of the dam; the arch in this bulkhead is therefore an invisible one.

As ordinary concrete is by no means impervious to water under the head of 200 pounds per square inch, it was decided to waterproof this bulkhead. The most economic method, consistent with good construction, was to face the entire pressure side with a 3-inch layer of waterproofing compound. This facing was carried up with the concrete, thus insuring a perfect bond. The subsequent test proved the efficacy of this facing.

*New York, N. Y. (Salt Lake Meeting, Am. Inst. Mining Engineers, August, 1914.)

To provide for future contingencies, involving a possible further waterproofing of the pressure side, it was decided to place a manway through the dam, thus permitting inspection or repairs.

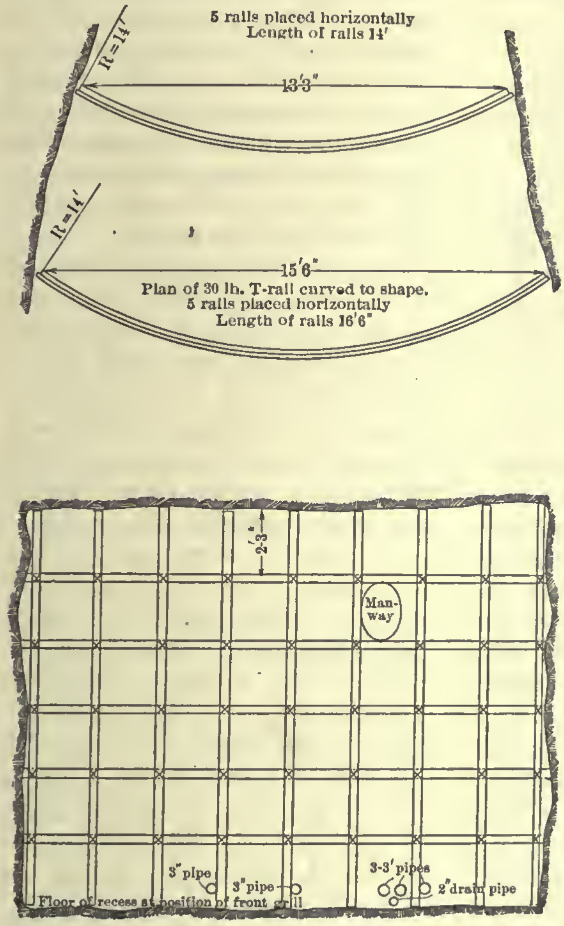


Fig. 2. Detail of Reinforcement Grill Built of 30-Pound Mine Rails for 16th-Level Bulkhead. Rails Spaced at 2-Foot Centers

The relative positions of the bulkheads on the 16th level are shown in Fig. 1. Attention is called to the fact that an old bulkhead leaked to the extent of about 6 gallons per minute, and that five pipes pass through it for the purpose of draining the water in the old workings by pumping it to the surface from the 16th level of the new workings after it had passed through the old bulkhead. The new bulkhead was designed to continue this function of drainage in case it should be so desired, and for this reason prolongations of the pipes pass through it. Due to the leak, when the new bulkhead is completed and its manway sealed, the water which passes through crevices in the old bulkhead will soon fill the space between the old and the new dams and the new bulkhead will then be assuming the entire load.

The details of the steel reinforcement placed in the dam are shown in Fig. 2, the horizontal rails being curved to the radius of the invisible arch. Great care was taken to thoroughly coat all metal surfaces with mortar.

The design of the manway is shown in detail in Fig. 4.

It was decided to use a 1:2:4 mixture of concrete for this bulkhead. Atlas Portland cement was used, and a local sand, carrying less than 3 per cent. of foreign matter, was obtained. The broken stone employed was a gneiss. This came from former ore dressing operations and was screened and washed before being used.

The construction of the 10th-level bulkhead presented no great difficulties. Ample storage space was available on this level and all the necessary materials were lowered

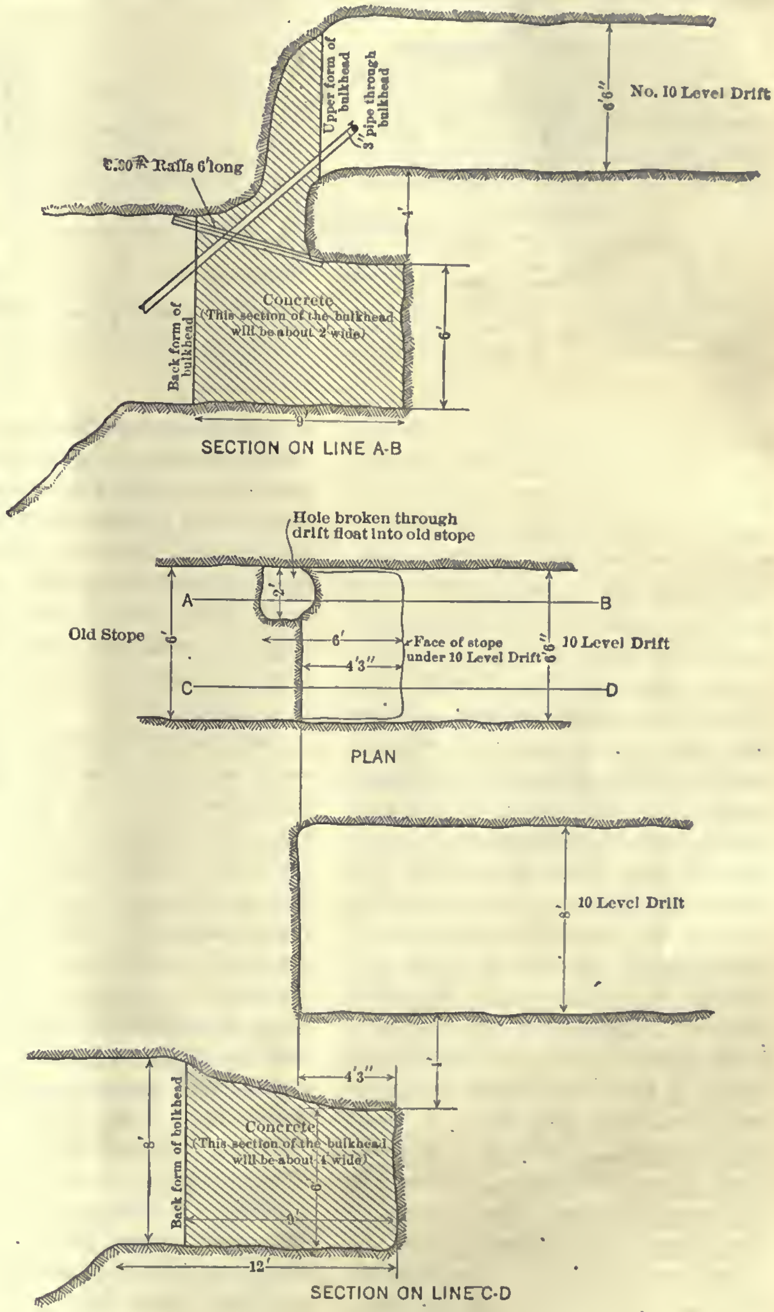


Fig. 3. Bulkhead at 10th Level

and stored near the site. After thoroughly cleaning and washing the mushroom-shaped cavity, Fig. 3, the forms were placed, and braced from behind with 6-inch and 8-inch round timbers. The inside of the forms was covered with tar paper, and a 3-inch drain pipe, for possible future use, was run through the forms. This pipe was fitted with a gate valve on the working side. Two-thirds of a cubic yard comprised a batch of concrete, which was mixed rather wet, so that after a batch had been placed water rose slightly above the level mass. Three iron rails were placed across the mouth of the cavity for reinforcement. The 12 yards of concrete were placed in 10½ hours.

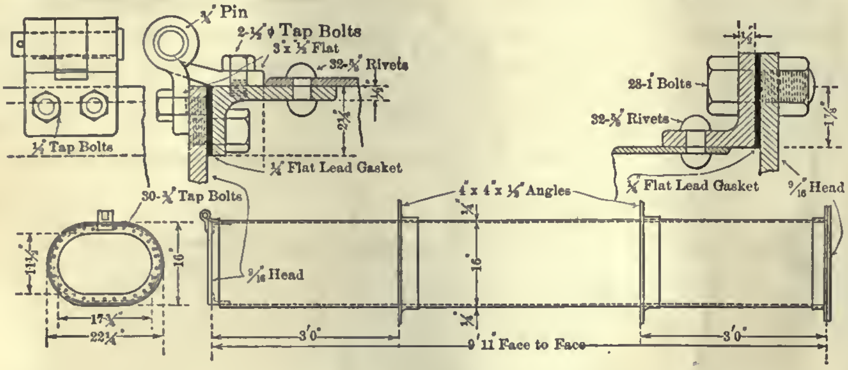


Fig. 4. Details of Manway

In drilling the recesses for the 16th-level bulkhead, care was taken to so point the holes that the excavation would coincide in form and dimensions to the design. At a distance of 25 feet from the old dam, holes 36 to 39 inches in length and spaced 1 foot apart were drilled in the sides, roof, and floor, at right angles to the course of the drift. Stoping and hand drills were used in this work and four men constituted the gang in this as well as in the subsequent work with column drills. Thirty-five feet from the old bulkhead a series of holes 4 feet in length and from 1 to 1½ feet apart were placed slanting to conform approximately with the inclinations of the skewbacks. These holes were only burdened with about 1 foot of ground. Under ordinary conditions longer holes would have been drilled, but the proximity of operating pumps made extraordinary precautions necessary for their protection during the shooting, and so heavy blasting was not attempted. A round of six holes was shot at a time. A third series of holes was drilled slanting to conform with the deeper portions of the recesses. When blasted, this series broke evenly at the line of the 3-foot holes first drilled and the resultant recess conformed almost exactly to the figure determined upon, and the total excavation agreed with the original estimate of 60 yards. The muck was economically disposed of in a nearby chute.

The materials required for the work were unloaded and stored close to the mouth of the shaft. Due to the lack of space on the 16th level, the matter of lowering and delivering the required materials without interrupting the work was one of the most troublesome obstacles encountered. Eight to twelve men were employed on the surface in sacking sand and stone while the excavation was in progress. The empty bags produced as the cement was used augmented the 200 old cement bags purchased for the sacking. While enough sand could be stored on the 16th level for this entire bulkhead, there remained insufficient room for the storage of the daily requirements of stone and cement. It was found advantageous, therefore, to employ a small night crew, who lowered much of the material required for the next day's work.

The ten curved rails were bent to a 14-foot radius over a form in half a day. This was done on the surface.

The forms on the 16th level bulkhead were built of 2-inch undressed lumber and 6 to 10-inch round posts were used for studding and braces. The forms were thoroughly braced and were wired to stiffen them further. The interior faces of the forms were covered with a tar paper, and the junction of the forms with the rock was plastered with a 1:1 cement mortar on all sides. The pressure-side forms were carried to the roof of the level at once, but did not extend into the recess.

The recess was thoroughly cleaned of loose rock and washed down, and all the reinforcing material, pipes, and the manway were placed in position before the concreting was started. Furthermore, the floor and sides of the recess were plastered with a 1:1 cement mortar before placing the concrete.

The concrete was made of one part cement, two parts sand, and four parts stone, these proportions being determined by actual measurement. A batch of concrete contained ⅔ cubic yard. The sand was first placed on the mixing platform and the heaps flattened down. On this was emptied the cement, and these two materials were thoroughly mixed and flattened out before receiving the stone. This mixing took place about 12 feet from the front form of the bulkhead. Enough water was used to make a wet mixture. Two men did the first mixing and turned the mass, then passed it on to the next two, who again turned it, passing the finished concrete to the last two men at the mixing board. These men shoveled directly into the form. In this manner, while each two men received a short rest of a few minutes between batches, fresh material was being placed on the starting end of the mixing platform while the men nearest the form were still disposing of the concrete mixture. This also insured a thorough mixing. One man remained in the form to level off each batch. The best day's work consisted in the placing of 12 yards of concrete.

The waterproofing compound, "Impervite," was carried up as a

3-inch facing, its level being kept the same as that of the concrete. An even thickness of the waterproof layer was maintained by the use of three forms of $\frac{3}{16}$-inch plate, 6 feet long by 6 inches wide, fitted at the upper corner with 3-inch spreading bolts. These forms, placed across the entire width of the face, were raised 3 inches to 4 inches at a time, and enough concrete was then shoveled against them to keep them in place. The almost semiliquid waterproofing compound was mixed on the level and was carried to the forms in buckets.

Before leaving at night, sharp stones, about 100 pounds in weight, were set at least 6 inches apart in the concrete mass. This made a strong bond, and before concreting the next day this rough surface was freshly plastered with a thin 1:1 mortar.

As the roof was reached, false forms were placed, and the work was finally finished in tightly bonded dovetailed blocks.

Throughout the work, the leakage from the old dam, 6 gallons per minute, passed through the 2-inch drain pipe of the bulkhead.

Seven 2-inch grout pipes, four on the pressure side and three on the opposite side, were placed in the concrete as the work neared completion. They were all located near the roof and were directed to such places as were most difficult to fill with concrete. As the work had to be hurried, but a day and a half elapsed after completion of the cement work before grouting was begun. The grout mixture was a mortar consisting of one and one-half parts of sand to one part of cement made fluid with water-dissolved "Impervite." A mine-made grout "gun" was used, and the grout was forced successively into the several pipes by means of air under the pressure of 85 pounds per square inch. As the grout was forced through the different pipes the ejection of some of this material through the other pipes indicated that the greater voids were filled. As the "gun" connections were changed those pipes giving the greatest discharge were plugged, and the discharge was finally limited to one pipe. This, too, was filled and plugged. The first day's grouting was allowed to set over night, and the following day all the pipes were again tested. This time there was no communication between the pipes, and as little or no grout could be forced into any one of the pipes the grouting was considered most satisfactory.

Three weeks were determined upon as the period which should elapse before the new bulkhead should receive any load. During this time the 2-inch drain pipe was left open.

At the expiration of this time the completed 16th-level bulkhead was tested by pumping water up to the pressure of 160 pounds per square inch into the space between the old and new bulkheads through the 2-inch drain pipe. The results were entirely satisfactory, as the total seepage amounted to only ½ gallon per minute at first. This small leakage subsequently stopped almost completely.

A cheap class of labor was employed exclusively, the men receiving $2 per 10-hour shift.

Following are tables showing the cost of the work. The interference caused by the necessity of keeping two large pumps in operation within 50 feet of the 16th-level bulkhead was perhaps the greatest cause for the apparent high cost. The labor cost of lowering materials was also high for the amounts handled, which, in the case of the 16th-level bulkhead, had to be lowered 1,350 feet in one skip.

Summary of Costs

Division	16th-Level Dam	10th-Level Dam
Labor	$ 790.00	$134.00
Superintendence	130.00	30.00
Transportation	50.46	4.50
Materials	503.88	37.23
Totals	$1,474.34	$205.73

Costs Per Cubic Yard

Division	16th-Level Dam	10th-Level Dam
Labor	$13.17	$11.15
Superintendence	2.17	2.50
Transportation	.84	.37
Materials	8.38	3.10
Totals	$24.56	$17.12

Storage-Battery Locomotives

Stewart S. Shive, district manager of the Jeffrey Mfg. Co., Chicago, whose excellent paper on "Storage Battery Locomotives" was printed in October, emphasizes the four cardinal points of storage battery locomotives and their application:

First. It is of the utmost importance that all of the experience and care exercised in the design of standard trolley locomotives should be used in the design of storage-battery locomotives. With the strong mechanical construction of the battery now available, the service which the battery locomotive will be called upon to perform and the abuse which it will receive will be equal to that which any other piece of mining machinery is subjected to, and it must therefore incorporate the elements of mechanical design which have proved satisfactory in ordinary trolley locomotives for mine service. The mechanical design must be such that all parts are easily accessible for inspection and replacement.

Second. It must be expected when the installation of the storage-battery locomotive is contemplated, to give it more attention and intelligent care than is ordinarily accorded a trolley locomotive. This should not be construed as meaning that there is an added burden on the storage-battery locomotive for attention and care above what attention is needed for charging. It simply means that the attention given the battery should be intelligently directed. For example, the battery must be kept clean, the electrolyte must be kept above the tops of the plates, and the battery should not be permitted to soak on full normal valued charging current after it has become completely charged. Violent gasing is detrimental to any battery. These are just a few points to illustrate

what is meant by intelligent care of the battery. In other words, the lid on the battery box should not be nailed down.

Third. The duty required of a storage-battery locomotive must be reasonable, both in point of speed and in point of tractive effort. The maximum speed at which it is desirable to operate a storage battery locomotive does not exceed $4\frac{1}{2}$ miles per hour at normal discharge rate of the battery, and the maximum tractive effort which a locomotive suitable for gathering coal may be expected to exert for any considerable length of time would lie between 1,000 and 1,600 pounds. A tractive effort of 1,600 pounds represents as large a battery as may be reasonably used on this kind of locomotive, and therefore, although the tractive effort may momentarily exceed this value, it should not be figured any higher if it is sustained for any considerable time. This consideration practically limits the application of storage-battery gathering locomotives to places where the grades are not severe and where the weight of the loaded train is not excessively great. It is also to be borne in mind that the amount of energy stored in a battery is limited and that therefore, a storage-battery locomotive cannot ordinarily be counted on to render economical service where the hauls are of any considerable length, say over 1,000 feet. A practically level mine, not too heavy trips, and short hauls, then, are the ideal conditions for the operation of a storage-battery locomotive.

The fourth point is one which is not generally believed. That is, that the operation of a storage-battery locomotive will, under many conditions, prove more economical than the operation of a cable-reel locomotive. It is generally granted that a storage-battery locomotive, because of the simplicity of its operation, would expedite the work of gathering coal, and this reason alone is very often sufficient to encourage its installation. If in addition to this, it may be proved to be actually more economical than a cable-reel locomotive, its advent in the coal mine should be received with enthusiasm.

Automatic Slate Control

The Lehigh Coal and Navigation Co. have been experimenting with a new device produced by the American Concentrator Co. that automatically reduces the quantity of coal in the slate discharge of a jig below 2 per cent. This apparatus has been in operation on a Joplin jig at the Greenwood washery, near Lansford, Pa., for over a month with marked success and will be attached to the other jigs in the washery as well.

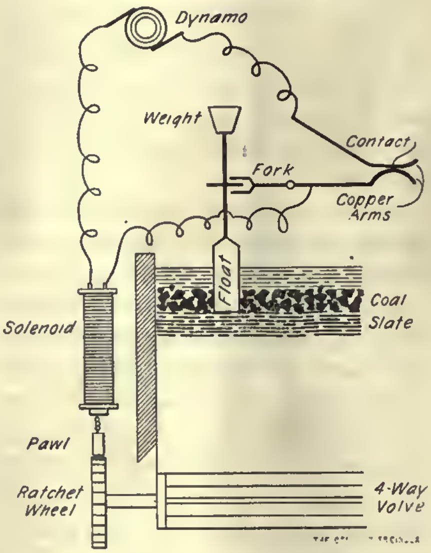


FIG. 1. AUTOMATIC SLATE CONTROL

Before the device was adopted, the jig runner was forced to watch the discharge continually and put his hand in the water to ascertain the height of the slate. This was trying, especially in cold weather. With this apparatus the action is entirely automatic. The solenoid and pawl, Fig. 1, are supported by a pair of arms which are oscillated by a shaft from the eccentric shaft of the jig.

The action of the apparatus is as follows: From an 18-volt dynamo a current of 20 amperes goes to the solenoid as shown. The current going through the solenoid holds up the iron rod to which is attached the pawl hinged to the arms supporting it. When the quantity of slate becomes excessive, the cylindrical tin float is raised and the fork is pressed up, which breaks the contact. The iron rod in the solenoid then drops and the pawl engages the ratchet wheel. Due to its oscillations, it rotates the wheel, causing the four-way valve to revolve and discharge the slate. When the slate goes out the weight presses down on the float and the contact is resumed. This sends the current into the solenoid and thus raises the pawl. The valve then ceases to revolve. The weight is determined by experiment, as it must force the float through the coal so it will rest on the slate. When once the weight is determined no further adjustment on that score is necessary. The dynamo will furnish enough current for all the jigs when equipped.

Cleaning a Centrifugal Pump

At the Johann Deimelsberg mine, in the Werden District, Germany, a centrifugal mine pump, which had to raise 6 cubic meters of water per minute to a height of 520 meters, worked under considerable disadvantage on account of mud clogging the pump. In order to prevent this deposition, the following plan was adopted:

After the centrifugal pump had been stopped the slush which collected in the pump was drained and clear water substituted; $1\frac{1}{2}$ to 2 liters of mineral oil was added and the pump put in motion and worked in dead water for a few minutes. Water and oil were thus mixed and all the internal parts of the pump wetted with the oily water. After the pump was stopped again, this oily water was allowed to remain inside the pump until it was put in use again. Since this process has been followed regularly, the clogging has ceased and the pump can be used steadily and with very little attrition.

At the sinking of a pump shaft in the iron-ore mines, Bülten-Aden-

stedt, of the Ilseder Smelting Works (mine district Goslar), a three-stage high-power centrifugal pump, which can raise the water to a height of 75 meters, and in which each stage corresponds with a height of water of 25 meters, is used as a sinking pump. In order that the height of water conform to the progress of the sinking, and to save power, at first only one stage was put up; with increasing depth the second, and finally the third stage.

Mine Mule Investigations

*G. E. Wentworth**

There seems to be considerable ignorance, owing of course to the lack of statistics, as to the merits and shortcomings of mules in the economic world.

A mule accords with the type of the sire and with the size of the dam. It is claimed he is less nervous and less subject to a fright than a horse; that he will thrive on poorer fodder and is less subject to disease; that in competition with a horse of equal weight, a mule will accomplish more; that the obstinacy of a mule is the result of ill usage; that he is more docile, more patient and more resigned; that it takes less feed to maintain a mule than a horse; that in a tug of war a mule will outpull his weight in horse flesh; that, his hide being tougher than that of a horse, he can stand more "cutting up" by ignorant drivers than his thin-skinned half-brother. Of course any one who advances this latter argument should himself be made the subject of at least one "cutting up."

At one time the life of a mule in the mines was figured at 4 years, but since skilled veterinarians have been employed to look after the livestock, drivers who viciously or ignorantly injure their animals are subject to fine and other penalties, and the average life of all work stock has been lengthened by several years.

The best mule is the product of two pure breds—of the jack, which traces its ancestry direct to the wild asses of Asia and Africa, through an unbroken line of pure blood, and of the draft mare, through selected lines of pure blood to the Arabian horse; yet, the mule is "without pride of ancestry or hope of posterity." He has ever been considered the humblest member of the horse family; the most patient, sure-footed, and enduring—the worst cared for and most cruelly treated of the race.

The average mule is an animal of bad conformation, though of fair size considering its parentage. It is comparatively narrow chested, of light barrel, high in the leg and deficient in courage. It is an animal slow of foot, slow in wit, nervous, timid, and distrustful. It is useful in mines where there is very little head room for a draft animal, but in high beds is greatly inferior to the horse.

The hybrid was first bred intelligently in the southern provinces of France and in Spain in the Middle Ages. The nobles were wont to impress into war service all horses and all able-bodied men. The peasants finally conceived the idea of breeding an animal large enough to till the soil and ridiculous enough to excite the contempt of their masters. Hence the large mule.

It is frequently asserted that a mule lives to a great age. Mine statistics show a mortality rate among mules that is tremendous. The states of the Cotton Belt replenish at a rate that indicates that at least every 5 years their entire stock of mules has been renewed. With the great breeding states added, it looks as though 6 years is an average working life for mules.

How often one hears the claim that "mules live and thrive on less food than horses." They exist on less when they get less. Their strength is sapped like that of any other living thing when there is little or nothing to eat. Statistics from mines show that, pound for pound, it takes as much to keep a working mule in condition as it does to keep a horse. A balanced ration is served out. The thirteen-hundred-pound half-caste cleans up the same ration as his stable mate of the full blood and requires the same amount of grooming to keep him fit.

The author has determined from the reports of experiment stations the cost of feeding mules and horses. When oats are worth $1.25 a hundredweight, corn $1.03 a hundredweight, and hay $15.20 a ton, it costs to feed a 1,258-pound mule on hay and oats 26.68 cents a day and a 1,447-pound horse 31.45 cents a day. On a feed of hay and corn at the prices given above, it costs to feed a 1,274-pound mule 23.23 cents a day and a 1,535-pound horse 27.21 cents a day.

For purpose of comparison it is customary in experiment stations to reduce all figures to the ratio of 1,000 pounds of live weight. After doing this one finds it costs to maintain a mule on hay and oats 21.2 cents a day and a horse 21.73 cents, and to keep a mule on hay and corn 18.23 and a horse 17.71.

It is customary to feed both oats and corn to working horses and mules in about equal proportions. Combining the above figures you find that it would cost 19.71 cents to feed a mule and 19.72 cents to feed a horse, showing that the cost of feed of the two under like conditions is almost exactly the same.

Indeed, the experiments of the Missouri Station, Bulletin 114, show that there is practically no difference in the cost of the keep of horses and mules of the same weight.

One writer states that "Mules can work day and night without being worn out." Even a donkey engine needs rest. The same authority also maintains that "Being light of limb and heavy in body, their weight is better disposed for moving heavy loads." Breeders of draft horses will not agree with this statement.

The breeder of the best mules begets them from standard and thoroughbred mares. The breeder of the best draft mules advertises that they are "out of the best draft or grade draft mares obtainable."

*Abstracted from article in *Country Gentleman.*

The seller of a mule points out to you and becomes most enthusiastic about the horselike quality of the animal he is showing: "He's just like a horse!"

Properties of Acetylene C_2H_2

Acetylene is a gas composed of 92.3 per cent. carbon and 7.7 per cent. hydrogen. It is used in mining almost entirely for illumination, replacing the smoky oil lamp to a large extent, and is obtained by adding water in drops to calcium carbide CaC_2, when the following reaction takes place and liberates the acetylene:

$$CaC_2+2H_2O=Ca(OH)_2+C_2H_2$$

The gas when pure has greater lighting power than any illuminating gas, one authority saying it furnishes a light 2.5 times brighter per unit of surface and has a lighting value 15 times that of coal gas. The ordinary miner's carbide lamp gives a candlepower, which varies between 10 and 15.

When acetylene is burned in air the reaction is:

$$C_2H_2+5O=2CO_2+H_2O$$

Its heat value compared with carbon, in pounds, is 1.48 to 1, and compared with hydrogen, volume for volume, is 4.53 to 1. The gas ignites at lower temperature than any other illuminating gas; viz., 800° F., and it decomposes into carbon and hydrogen when subjected to a temperature of 1,436° F.

It is stated by H. Le Chatelier the temperature of acetylene decreases with the air furnished for combustion, but when given pure oxygen for combustion will furnish a temperature 1,872° F. higher than the oxyhydrogen flame.

Acetylene 7.74 parts, air 100 parts gives a temperature of 4,388° F.; acetylene 12 parts, air 100 parts gives a temperature of 4,100° F.; acetylene 17.13 parts, air 100 parts gives a temperature of 3,812° F.; acetylene 1 volume, oxygen 1 volume gives a temperature of 7,232° F.

Autogenous welding is another practical example of the use of acetylene.

Calcium carbide CaC_2 from which acetylene is derived is manufactured by combining lime CaO and carbon C in an electric furnace. The equation representing the reaction is

$$CaO+3C=CaC_2+CO$$

One pound of calcium carbide contains 21.64 cubic inches and will yield about 4.8 cubic feet of acetylene gas.

In the ordinary miner's lamp 1 ounce will last 2 hours, and at 10 cents a pound cost the miner 2.5 cents for 8 hours of light. One cubic foot C_2H_2, at 32° F. and 30 inches mercury, weighs .07346 pound, and in burning produces 1,576 British thermal units, which, reduced to work, is equivalent to about 2.75 cubic feet of coal gas. According to M. P. Villard, acetylene becomes a liquid under a pressure of 382.9 pounds per square inch and a temperature of 0° C.

One cubic foot of liquified acetylene weighs 25 pounds and is capable of evolving 400 cubic feet of acetylene gas.

The explosive force of acetylene owing to the great heat evolved is about the same as gun cotton or 5,280 atmospheres, 38.8 tons per square inch.

Explosive mixtures of air and acetylene gas range all the way between 4.7 per cent. and 57 per cent. in volume, while the maximum explosive force occurs when air is 7.8 per cent. to 12.8 per cent. by volume more than acetylene.

Comparison and Cost of Illuminants

Name	Consumption Per Hour Grains	Light Evolved Candle Hours	Candle Hours For Cost of 1 Cent
Stearine candles	135	1.20	3.45
Paraffin candles	122	1.46	11.16
Carcil lamp, Colza oil	463	9.60	11.23
Kerosene, Argand burner	106	15.00	94.50
Acetylene	1 cubic foot	50.00	100.00

Exceptional Mine-Car Service

The road from the railroad station to the mine of the Pond Creek Coal Co., in Kentucky, is exceedingly rough, 6 miles long, the major portion of it being a creek bed. Before the railroad was completed to the mine, the machinery and equipment needed was, of necessity, transported over this road.

The mining company purchased 800 mine cars equipped with Hyatt flexible roller bearings from the Hockensmith Wheel and Mine Car Co. The first twenty-five of these cars, shipped in September, 1912, had to be hauled, on their own wheels, from the railroad station to the mine. Four-mule teams were used to pull each car. At some few points along the stream the water was 3 feet deep, and the cars floated. When they reached the mine opening they were placed on the tracks, given a little additional oil, and without cleaning or removal of the wheels, were put in service. These cars are still in service and in good condition, meeting all requirements as to durability and saving of haulage power.

That mine car wheels equipped with roller bearings are durable as well as economical in power is doubted by many mine managers, notwithstanding shop tests have proved this. These officials do not doubt the results of shop tests, but they say "yes, your shop test under shop conditions prove your claims, but what will be the result of actual mine tests? When we can be assured of satisfactory results in mine tests we will be interested."

The above test of a nature never contemplated by car manufacturers or the roller-bearing people, is conclusive evidence of the strength and durability of the roller bearings as well as of the mine cars themselves.

The Ebensburg No. 1 mine of the Ebensburg Coal Co., at Colver, Pa., established a new record, the production for the month of October being 102,700 net tons.

The Royalton Mine Explosion

Extent of the Disaster—Number of Men Killed—Methods Used in Rescue Work—Probable Cause of the Explosion

Written for The Colliery Engineer

An explosion which cost the lives of one less than the number of men killed in the explosion at Ziegler, April 3, 1905, and therefore the second most disastrous in the coal fields of southern Illinois, occurred at the North mine of the Franklin Coal and Coke Co., at Royalton, on Tuesday morning, October 27, 7:25 A. M. Fifty-two men were killed either by the explosion or by the afterdamp following the explosion.

Tipple at Royalton Mine

After the Accident, Royalton Mine

Royalton is a town of about 2,000 population, in the southern end of Franklin County, near the Williamson County line. It is on the Iron Mountain Railroad, about 85 miles southeast of St. Louis. There are but two mines in the town, both being owned by the Franklin Coal and Coke Co., these being known as the North and South mines. The seam worked is the No. 6 in the Illinois series, and in this neighborhood it is from 10 to 12 feet thick.

The coal is so hard it is possible to prepare it in 7 sizes. An analysis furnished gives the following composition:

Moisture, 4.60; volatile matter, 34.89; fixed carbon, 49.37; ash, 11.14. Total, 100. Sulphur, .94.

A section of the bed taken near Ziegler about 4 miles distant by the United States Bureau of Mines is as follows:

Coal 3 feet 2 inches, blue band 1 inch, coal 2 feet, mother coal ½ inch, coal 2 feet, blue band ½ inch, coal 3 feet 10 inches. Thickness of bed 11 feet 2 inches. The depth of the coal from the surface is 363 feet at the North shaft. It is the practice in the North mine to leave 3 feet of top coal for a roof, this being taken down on the entries, and it forms so strong a roof that no entry timbers are needed. Above the coal is a limestone which is also exceptionally strong, and it is very seldom that a fall of roof is found in the mine.

The mine is worked on a panel system, main north, south, east, and west entries being driven from the shaft bottom, and cross-entries from these. Rooms are driven on 50-foot centers, the average width of the rooms being about 25 feet. Entry pillars of from 100 to 125 feet are carried to protect the main entries, and smaller ones along the cross-entries. The rooms driven from parallel entries are not holed through, a pillar of from 10 to 20 feet separating the two panels.

The method of working is to open five new rooms and work them as usual with machines, then start five new rooms and in the meantime rob as much as possible of the coal in the first five. Thus 10 rooms are being worked at the same time from the same entry. The coal cutting is practically all done by Sullivan, Goodman, and Morgan-Gardner machines, and the haulage by Goodman, General Electric, and Morgan-Gardner electric locomotives, with a few mules, only one of which was killed by the explosion. Shot firers are employed by the company to shoot down the coal, all shooting being done after the men have left the mine.

The coal field of Franklin and Williamson counties is known as the most gaseous in Illinois, and the North mine, at Royalton, is rated as a gaseous mine. The ventilating system at the mine is good, and at no time has it been thought necessary to put the mine on safety lamps, naked lights being used in all parts of the mine. The fan is a primarily blowing, reversible Sirocco, 20 feet in diameter, with blades 5 feet in width, guaranteed to deliver 200,000 cubic feet of air per minute when running at 225 revolutions per minute.

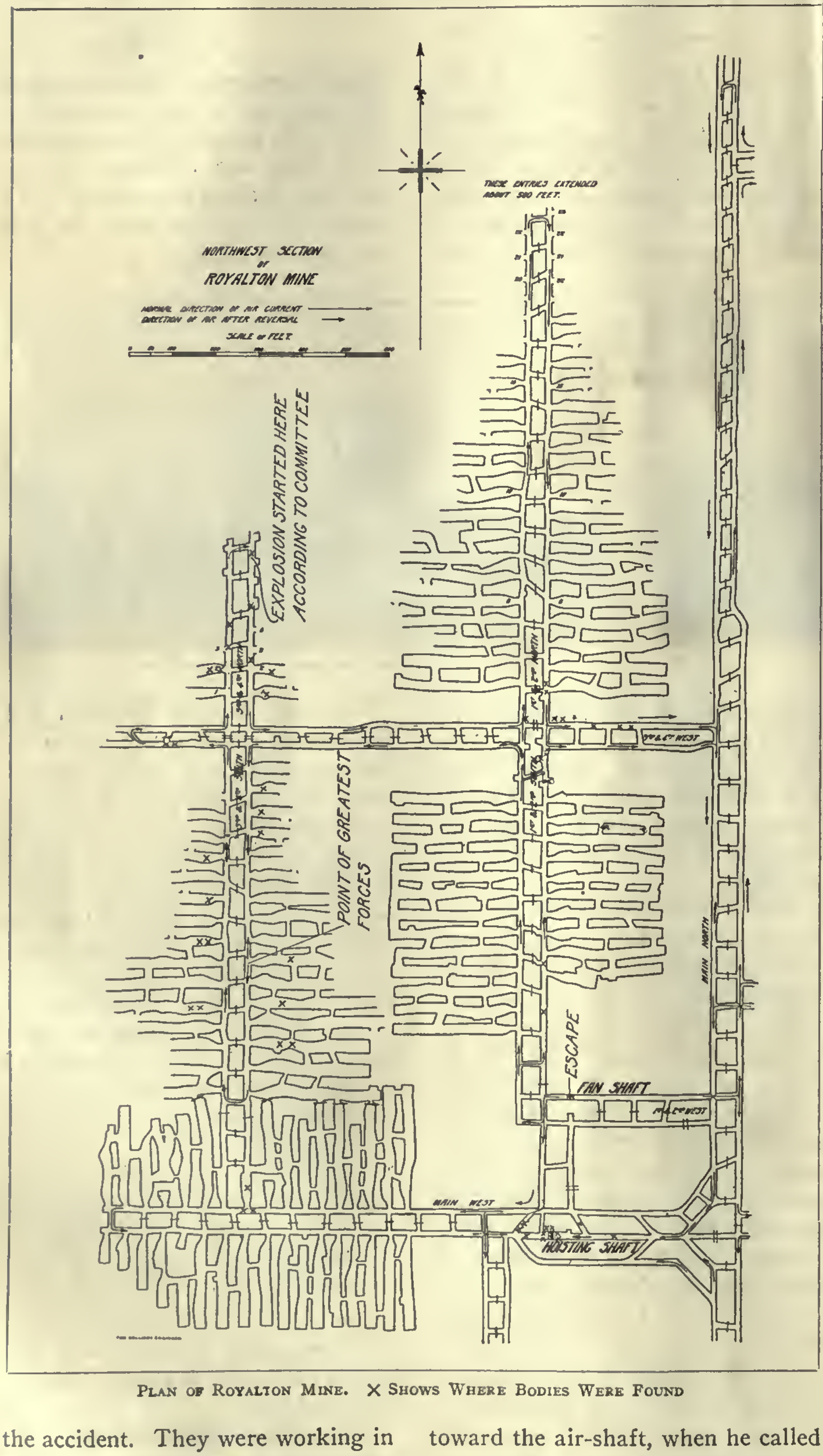
The official data relative to the number of men in the mine on the morning of October 27, follows:

The explosion occurred at 7:25 on morning of October 27, a particularly cold and windy morning; 357 went down between 6:30 and 7:25 o'clock, the majority between 7:00 and 7:25.

Of the 52 dead, 43 were in northwest and 9 at the bottom.

Of the 305 rescued, about 213 were in northeast and southeast and

did not know about accident until Mine Manager J. B. Brown, who had reversed the air, went down and told them. Thirty-eight knew about the accident. They were working in west, and rushed toward the bottom of the air-shaft. Two escaped that way; the 36 were found later by Mr. Brown, who brought them out by a short cut; 52 were at the bottom of the shaft when Mr. Brown first went down, and were headed toward the air-shaft, when he called them back.



Plan of Royalton Mine. X Shows Where Bodies Were Found

Of those in the mine, 14 per cent. were killed; 26 per cent. knew about the accident and were escaping; 60 per cent. did not know about the accident until told.

Of the dead 30 were married, 21 were single, 1 doubtful, and 6 were Americans, 3 were Scotch, and 1 Welsh, 28 Slavs, 14 Italians.

Of these 46 were miners, 2 were machine men, 4 were shift men.

The injured numbered 19; three went to Ziegler Hospital and three to Herrin Hospital. One has since left Ziegler.

Only two were seriously injured. They are in Herrin Hospital. There were 550 miners on the union roll, and as many as 600 miners have been on the company pay roll.

From this it is seen that not all the men had entered the mine, 40 or 50 of them being on the surface and many of those in the mine were on the entries when the explosion occurred.

To those on the surface, the only indications were a cloud of dust and smoke coming out of both the hoisting shaft and the fan shaft. In the engine room the circuit breaker was blown out. No damage was done in either shaft, nor was the fan injured in any manner. The mine manager, James Brown, was in the engine room at the time, and he immediately ordered the fan to be reversed. While in a great majority of cases the reversal of the fan is an action which cannot be condemned too strongly, in this case Mr. Brown evidently knew conditions thoroughly, and it proved to be the one thing to be done, and although 5 or 6 men at the most may have been overcome by afterdamp through the change in the direction of the air-current, it is probable that but very few of the 305 men who escaped would have done so if the fan had been continued as a blower. General Manager Sine has an effective rescue and first-aid organization, and many who had been overcome were revived by the splendid expert work of the first-aid corps at the surface.

After the reversal of the fan, the men on the surface entered the mine as rapidly as they could do so,

Royalton Mine—Waiting for the Bodies to Be Brought Out

and succeeded in rescuing several men about the shaft bottom and on the Main North entry, and at the same time recovered the bodies of some who had been killed outright. The rescuers found that the explosion took place in the northwest section of the mine, and that men in other sections were not only uninjured but were unaware that an explosion had occurred. Machine men were found by their machines waiting for the power to come on again, a drop in the power being a not infrequent occurrence. In all, 297 men were brought out of the mine safely, many of them having been interrupted in their regular work by the rescuers.

Calls were immediately sent out for help, and at about 10 A. M. a crew of eight helmet men from the Benton Mine Rescue Station, in charge of James Towal, superintendent of the Benton Station, accompanied by Oscar Cartlidge, manager of the Illinois Mine Rescue Stations, arrived at the mine ready for work. They were followed soon by the rescue crew of the Madison Coal Corporation, at Dewmaine, in charge of John Lyons, and by helmet men from the Saline County Coal Co. No. 3 mine, at Harrisburg, with their equipment. As soon as the news of the explosion reached the surrounding mining communities trained men responded to the call, and at no time during the recovery operations was there a shortage of men ready to undertake any work that might be assigned to them.

That such a body of men trained in the use of the oxygen helmet and in mine rescue work could be assembled in so short a time is a triumph for the organization and management of the Illinois Mine Rescue Station Commission, a line of work in which Illinois has taken the lead, and in which other states might well follow. At the last meeting of the Commission, the manager was authorized to form, at each of the three stations, LaSalle, Benton, and Springfield, a corps of five men who were to keep in continual training, taking at least 2 hours training each week, and who were pledged to respond to any call, at any time. The Benton corps proved the value of such a course when they responded to the call in so short a time, even though this involved an automobile trip of approximately 20 miles over very rough roads.

House Used as Morgue, Royalton Disaster

Prior to the arrival of the helmet men, the men from the mine had succeeded in penetrating as far as the fourth West off the Main North entry, and in bringing out all bodies found. Beyond there it was impossible for them to go without helmets, the air being fouled by the explosion to too great an extent. When the helmet men entered the mine, an investigation proved that there was no fire in any part of the mine. It was found also that all the ventilating system inside the third and fourth West entries had been deranged and that it would be necessary to rebuild all the stoppings and brattices in this section. One overcast was completely torn out on the west side of the shaft bottom. In addition to the damage done to the ventilating system the haulage system in the northwest part of the mine was damaged, cars being destroyed and the trolley wire being torn down; it is probable that the whole damage done to the mine will not exceed $1,000.

The first helmet men to enter the mine were James Towal, superintendent; M. J. Carraher, assistant superintendent; Walter Nichols, assistant superintendent; William Watson, James Thomson, Alex. Marshall, captain; Walter Anderson, and Mungo Marshall. While they were making their inspection, boards and canvas with the necessary tools for the construction of stoppings and brattice were being sent into the mine, and the work of conducting the air into the affected sections was begun. On the reversal of the fan, the hoisting shaft became the downcast, and the air split naturally, going to all sections of the mine. At the inside of the parting on the shaft bottom, brattice was built so as to allow but a small portion of the air-current to go to the south, the most of it being carried directly up the Main North entry. The brick stoppings along the Main North were found to be in fairly good condition, and required but little patching to make them practically air-tight. Just beyond the fourth West entry a canvas stopping was erected, to deflect all the air into the fourth West. From here the air was coursed through the rooms off the first and second North entries, helmet men going ahead and locating the bodies and carrying them to fresh air, from which point they were taken to the foot of the shaft by the stretcher corps. As the helmet corps consisting of Walter Nichols, John Lyons, Dan Holly, Sylvester Hooper, and Joseph Bell worked their way through the rooms off the first North and thence through the inside cross-cut to the second North, examing each room, they found a man alive in room No. 25 off the second North, with his carbide light burning. The man was somewhat delirious, but still conscious, and on being given oxygen through the feed-pipe of one of the oxygen apparatus, he revived and was brought to the surface. He was found at about 4:30 P. M. about 9 hours after the explosion, being the only live man found in the affected section.

After finishing the examination of the rooms off the first and second North entries the rescuers proceeded along the fourth West entry, replacing all the entry stoppings as they went. At about 400 feet east of the third North is a parting on which stood from 20 to 25 loaded cars. These cars were piled together by the force of the explosion so that there was barely room for the men to pass them, and considerable time was required to make the place passable. That this trip of loaded cars saved the part of the mine outside of the parting is the opinion of all who saw conditions on the parting, for the cars were piled together in such a way as evidently to have stopped the explosion in that direction. The third and fourth North entries and rooms were next examined, and from the evidence found there is little doubt but that the explosion started near the face of the fourth North entry. Men found up to this place had been killed either by the force of the explosion, or by afterdamp, but the bodies recovered from this point on had been burned to a considerable extent.

The work of recovering the bodies and restoring the ventilation was carried on through the third and fourth North entries and then the third and fourth South entries, in all of which men were found who had been badly burned.

In all, 36 bodies were recovered by the use of the helmet, five bodies were found in the work of cleaning up the mine after the restoration of the ventilation, and 11 bodies were found near the shaft bottom by those who entered the mine immediately after the explosion. The helmet men found five bodies on the second West, three on the first and second North, three on the first South, eight on the third and fourth North, two on the third and fourth West, eight on the third South, and seven on the fourth South.

In addition to the helmet men named, the other helmet men who assisted in the work of recovering the bodies and restoring the ventilation, were Joseph Dixon, Alex. Hudson, George Clayton, Frank Lauder, John Lowes, George Talbot, W. G. Taylor, Thomas Jenkins, Samuel Jenkins, Joseph Goff, and William Milam.

During the work, frequent calls for volunteers to assist in building brattice, carrying material and removing dead bodies, met with ready response from the men gathered around the head of the shaft.

A great handicap in pushing forward the work with speed was the scarcity of safety lamps, and requests for the loan of lamps were sent to the surrounding mines. Among those who furnished lamps for the work were the Chicago, Wilmington & Vermilion Coal Co., the Chicago & Carterville Coal Co., and the Illinois Miners' and Mechanics' Institutes.

Following an extended examination of the mine made by various state and federal mining men, the following official statement was given:

"It is the general opinion of the undersigned that the gas explosion which occurred at the Franklin Coal and Coke Co.'s North mine at Royalton, Ill., October 27, 1914, was started by some one crossing the mine examiner's 'Danger' mark and igniting the gas in the third West entry."

Signed:

George L. Morgan, State Inspector.

John McClintock, State Inspector.

James S. Reid, State Inspector.

Edward Laughran, County Inspector.

John Bohlander, President State Mining Board.

E. D. John, General Supt. of C. and C. Coal Co.

James B. Brown, Mine Manager Franklin Coal and Coke Co.

R. B. Mitchell, Supt. F. C. and C. Co.

Charles Krallman, General Inspector Peabody Coal Co.

At the coroner's inquest it was established that the mine examiner marked a place as containing gas, and that the place was entered in

Helmet Team, Benton Mine Rescue Station—Helmets On

his report book, but that he did not find a sufficient quantity to cause him to withhold the miner's check. Investigations showed that a tie marked "gas" had been placed across the entry at this point.

To prevent accidents of this kind the company takes the following precautions: Two men go into the mine before starting time to make safe the working places which have been marked out by the examiners, of whom there are two; and a man is employed to attend to the fire-check system and hold back the checks of those men whose places have been marked "unsafe."

Two ways in which the gas may have been ignited are advanced by men who investigated the conditions, and it is a difficult matter to establish the cause of the explosion except by one of these hypotheses. One is to the effect that the gas was ignited by a naked light; the other points out that at the face of the fourth North entry there were indications of a blown-out shot, and draws the conclusion that a blown-out shot in the presence of a small amount of methane ignited the coal dust and exploded some powder in the kegs, which were seen near badly burned bodies.

Since the above was written, another supposition is that a miner

Helmet Team, Benton Mine Rescue Station—Helmets Off

Reading from left to right: James Towal, Supt.; M. J. Carraher, Asst. Supt.; Walter Nichols, Asst. Supt.; William Watson; James Thomson; Alex. Marshall, Capt.; Walter Anderson; Mungo Marshall

going to work stepped into an old room just off the entry and his open lamp ignited a body of gas. In corroboration of this it is stated that the top coal of the entry was blown down at this point and the man buried beneath the fall. The official statement reads, the "Explosion is supposed to have occurred in the third Northwest entry, caused by some person, unknown, crossing the Mine Examiner's 'Danger' mark placed there some time before 3 A. M. and igniting the gas."

With the exception of the derangement of the ventilation and the necessity for rebuilding brattices and stoppings, no serious damage was done to the mine, and work was resumed about a week after the explosion.

Practically there was no distress among dependents of the dead, as these wants were covered by state and local Union benefits.

Legal Decisions on Mining Questions

Validity of Statute Regulating Coal Mines.—(Federal Court) An important question involving the right of a state to regulate the weighing of coal at mines in cases where miners are paid according to the quantity of coal produced, is presented in the case of Rail and River Coal Co. *vs.* Yaple, recently decided in the United States District Court for the Northern District of Ohio. The suit is the outcome of a law passed by the state of Ohio early this year which provided for such weighing at mines and gave to the State Industrial Commission the power to fix the standard for compensation in cases where disputes arose between miners and operators. The motive of the Ohio Legislature in formulating the law was to put an end to the engendered disputes and bitter feeling which arose between the United Mine Workers and the mine operators of the state. The system of paying miners long in vogue in nearly all Ohio mines originated when only lump coal was marketable and is based on the amount of coal mined and passed over a 1¼-inch screen, which amount is assumed to be 28 per cent. The insistence of the miners that they are paid for but a part of the product of their labor began when the finer grades of coal became salable. The plaintiff corporation, a large producer of coal and employer of mine laborers, of whom there are more than 45,000 in Ohio, charges that the act, in lodging in the Industrial Commission the duty of determining the percentage of impurities unavoidable in the proper mining or loading of coal, and fixing, in case of disagreement between the mine operators and his employes and until they subsequently agree, the percentage of fine coal allowable in the output of the mine, unreasonably, unnecessarily, and arbitrarily deprives the operator, whose business, it is alleged, is strictly private and unaffected by any public interest, from contracting with his employes for the production of coal containing more impurities or having a greater degree of purity than that which the Commission has fixed, and denies him the right to reject, and requires him to accept and to make payment for the total contents of each mine car, without deduction or diminution, so long as the percentage of impurities fixed by the Commission is not exceeded. The further claim is made that the act is not designed to protect the morals, health, or safety of the public or mine employes, and has no real or substantial relation as between the purposes attributed to it and the means devised for attaining such purposes, but has for its object the regulation of the relations between masters and such of their servants as are paid by weight of coal mined or loaded and that it is therefore unconstitutional, in that it deprives the plaintiff of liberty and property without due process of law, and of the equal protection of the law as guaranteed by the fourteenth amendment to the Federal Constitution and the Ohio Bill of Rights.

The Court in disposing of the case held that the act was not unconstitutional, that the business of mining coal is affected with a slight degree of public interest, sufficient however to justify appropriate legislation regulating the manner of paying employes, where such regulations will operate to allay discord among mine workers and conserve the coal supply. The police power of a state extends to the making of regulations promotive of domestic order, morals, health, and safety, to the removal of causes giving rise to disputes between capital and labor, to provision for the safety and health of miners, and to the regulation of mines and mining and the conservation of minerals.—*Rail and River Coal Co. vs. Yaple. 214 Fed. 275.*

Ventilation of Mines.—In pursuance with Section 7381, of the Washington State Mining Law, relative to the ventilation of coal mines, the estate of William Brown brought suit against the Pacific Coast Coal Co. to recover for the death of Brown caused by firedamp. The record in the case disclosed the fact that Righi, the fire boss, whose duty it was to make the daily inspection as required by the statute, performed his duty in a careless manner, failing to detect damp when he should have done so. The carelessness on his part was attributed as the cause of Brown's death. The company claimed that it could not be charged with the death, as the act was that of a fellow servant and not that of a representative of the company, the rule of law being that a master is responsible for the wrongful acts of his agent or representative but not for those of a fellow servant. The United States Circuit Court of Appeals, Ninth Circuit, decided the case in accordance with the reasoning of the company's counsel, saying that Brown's fellow servant was the cause of his death and that his estate was precluded from making any recovery from the company which employed both Brown and Righi.—*Pacific Coast Coal Co. vs. Brown. 214 Fed. 255.*

Colliery Repair Shops

What Constitutes Complete Shops, Both Electrical and Machine—Practical Examples From Different Mines

By William Z. Price

BY FAR one of the most important links in the chain of successful mine operation is the repair shop. Its value depends upon its equipment and ability to cope with any contingency which may arise.

In the machine shop, a certain definite number of machines is imperative to give adequate service, but a complete shop should have a lathe for large work and one for smaller purposes, a drill press, a planer, a pipe threading machine, a steam hammer, a hydraulic press, and a traveling crane. These together with emery wheels, saws, etc., would complete a shop which should satisfy the most exacting machinist.

Engine and precision lathes for drilling, tapering, countersinking, etc. are the common designs found at collieries.

Drills to be of any value for boring holes in iron and steel must have a central grinding or leading point, the cutting edge must have ample clearance and there must be a suitable shank for gripping the drill.

Where shops do not have a hydraulic press for pressing gears, pinions, etc., to shafts, it is necessary to use the shrinking method unless it is desirable to fasten them to the shaft by a key or setscrew.

W. S. Leonard in his book on "Machine Shop Tools and Methods," says that an allowance of .001 inch of shrinkage per inch of diameter, is a satisfactory rule for large work but for diameters less than 12 inches use the formula:

$$\frac{\textit{Diameter of shaft}}{1,000} + .001 \text{ inch}$$

INTERIOR OF SHOP OF CONNELL ANTHRACITE MINING CO., BERNICE PA.

The following table is commonly used:

Size in Inches	Allowance for Shrinkage
2 inches and under	$\frac{1}{500}$ inch or less
2 to 4 inches	$\frac{1}{300}$ inch
4 to 6 inches	$\frac{1}{200}$ inch
6 to 9 inches	$\frac{1}{125}$ inch
9 to 12 inches	$\frac{1}{80}$ inch
12 to 18 inches	$\frac{1}{64}$ inch
18 to 24 inches	$\frac{1}{50}$ inch
24 to 35 inches	$\frac{1}{32}$ inch
35 to 45 inches	$\frac{1}{24}$ inch
45 to 55 inches	$\frac{1}{20}$ inch
55 to 65 inches	$\frac{1}{16}$ inch

STEAM HAMMER BERNICE SHOP

LOCOMOTIVE HOUSE, KINGSTON COAL CO


Left-Hand Side of Machine Shop, Kingston Coal Co.


Right-Hand Side of Machine Shop, Kingston Coal Co.

It is important to cool the enveloping piece as soon as practical or keep the shaft cool; otherwise the shaft may expand, which might stretch the outer piece.

The company having one of the best examples of mine machine shop practice in the bituminous region is the Allegheny River Mining Co. at its two Furnace Run mines near Kittanning, Pa. The shop is in three sections, as may be seen on page 271. From right to left they are, the machine shop, the foundry and the wood working shop. The first named is equipped with a 10-ton electric crane, a pipe threading machine, 36-inch and 16-inch engine lathes, a 600-hundred pound air hammer, a bulldozer, a 42-inch radial drill, a milling machine, a 24-inch shaper and a punch and shears combined, all with individual motor drives. A sensitive drill, a centering machine, a cutter and tool grinder, and an emery grinder are driven from a line shaft.

The foundry equipment consists of a brass furnace, a 46-inch cupola with the necessary accoutrements, and a core oven, with small tools.

The wood working shop has a 20-inch wood lathe for pulley and roller work, a 36-inch band saw, a saw table, a swing saw, a wood boring machine, and a post borer.

The three buildings are of Hy-Rib construction with an 8-inch concrete wall as a base.

Near Bernice in the northeastern part of Pennsylvania is the machine shop of the Bernice mine of the Connell Anthracite Mining Co. This shop presents an excellent example of equipment for an isolated mine. All the brass, as well as sprocket wheels, gears, pinions, pistons, piston-rings, rods, etc., are bought in the rough and machined at the mine.

A single acting, $10'' \times 16''$ steam engine in the center of the shop, drives all the machines by overhead shafting. The shop measures 55 ft. $\times 80$ ft. and is well lighted by steel sash windows. The equipment consists of an 8-foot Fitchburg engine lathe with a 24-inch swing, a 14-foot Davis engine lathe with a 24-inch swing, and a 5-foot Star engine lathe with a 14-inch swing. The Fitchburg lathe is used for boring out car wheels, boring and turning new bushings and in turning commutators when renovating motors. The Davis lathe is used principally for turning piston heads, rods, and rings, motor and engine bearings, and all heavy work. The Star lathe is used for any small work.

A Dresser drill press with a 3-foot radial drill is used for drilling rack rails, latches, scrapers, trough irons, sprocket wheels, etc. A planer 5 feet wide and 14 feet long is used for making switch points, and on valves, key seats for shafting, etc.

A steam hammer and a pipe threading machine complete the mechanical equipment of the shop.


Interior of Electric Repair Shop, Kingston Coal Co.


Exterior Electric Repair Shop, Kingston Coal Co.

The feature of the shop is the method of turning over the cars so they can be repaired. It is done by means of an overhead 2-inch solid steel shaft, 30 feet long. Four drums are keyed to the shaft, which is belt driven. Three of the drums are 18 inches long, each wound with a hemp rope which has a hook on the end for gripping the car. The fourth drum is 36 inches long and holds the rope used for pulling the cars up the short incline from the breaker into the shop for repairs.

In one corner are two blacksmith forges, connected to one small fan. All machines are belted to the shafting by the loose-belt plan.

At the No. 2 mine of the Kingston Coal Co., near Wilkes-Barre, Pa., is another shop that represents the most modern practice, and has the minimum number of machines for the various contingencies that arise, showing high efficiency.

The shop took the place of four other distinct shops, (blacksmith, machine, car repair, and carpenter). It measures 60 feet wide by 105 feet long and employs almost 50 men.

The equipment consists of six forges, a 27-inch drill press, a bolt cutter, a 4-foot lathe with 14-inch swing and a 7-foot lathe with a 24-inch swing, a shaper, a pipe threading and cutting machine (from $2\frac{1}{2}$ to 10 inches), a wood turning lathe, besides emery wheels, circular saws, etc. A single-acting $13'' \times 16''$ Atlas engine drives all the machines by overhead shafting. The loose-belt and loose-pulley method are both used.

The wood turning lathe is used principally for turning the rollers and pulleys used on the slopes. These are turned from scrap ends of mine timber.

An iron fence shown at the right of the view on page 270 partitions two of the forges from the rest of the shop. These are for drill sharpening, and this part of the shop is always free of access from the outside.

Adjoining the shop is a new locomotive house. Steam locomotives are used about the mine and the rails in the new house are laid on piers, permitting easy access to the under side of the engine.

At the No. 4 mine of the same company, a short distance away, there is a modern electrical repair shop which is decidedly interesting. It is a concrete building, faced with brick, fitted with large steel window sashes, and is fireproof in every particular.

Shops of Allegheny River Mining Co., Furnace Run, Pa.

The shop is the clearing house for all the electrical equipment about the mine. Armatures are wound, commutators turned, all telephone, electric signal, and lighting repair work is done in the shop, which is divided into three sections, the repair room, supply room, and telephone exchange. The latter part also is the office of the chief electrician.

The equipment of the repair room consists of an 8-foot lathe with 24-inch swing, an armature winding back and a controller and switchboard used for testing repaired motors.

PERSONALS

Dr. David T. Day, the petroleum expert of the United States Geological Survey, has resigned, and the work of getting out the statistics and compiling the 1913 report has been turned over to John D. Northrop.

Fred Vinton, for 8 years mine foreman for the Penn Mary Coal Co., at Heilwood, Pa., has resigned to become superintendent for the Greenwich Coal and Coke Co., at Saxman, Pa.

Benjamin F. Daddow, of Ashland, Pa., who for a number of years was chief clerk to the division superintendent of the Lehigh Valley Coal Co.'s Schuylkill Division, with offices at Centralia, Pa., has been promoted to the position of chief clerk to General Superintendent Thomas, with headquarters at Wilkes-Barre, Pa.

On November 1, F. B. Lockhart, president and general manager of the Baltimore & Ohio Coal Co., became associated with J. H. Hillman & Sons Co., of Pittsburg, Pa.

W. E. Jones, of Sheridan, Wyo., who has been mine inspector of District No. 2 since February, 1911, has resigned to take a position with the Big Horn Collieries Co., at Crosby, Wyo.

George Akin, of Diẽtz, Wyo., has been appointed mine inspector of the Second District by Governor Joseph M. Carey, to take the place of W. E. Jones, resigned.

Michigan College of Mines in August conferred the degrees of Engineer of Mines on the following young men: Frederick A. Barkell, Hubbell, Mich.; Harold K. Boysen, Abraham Cohn, of Chicago; Fredric Gibbs, Elmer M. Haug, Angus J. McDonald, Harold F. Mills, Wilfrid C. Polkinghorne, Hancock; Charles J. Rashleigh, of Houghton; Paul E. Hinckley, Kalamazoo; Barney Hirshberg, Ralph A. Loveland, George F. Schreiber, Saginaw; Lester N. MacDonald, Virginia, Minn.; Philip A. Maverick, San Antonio, Tex.; Homer M. Northrup,

River Rouge; Pius Pastorino, Flint; Robert M. Peterson, L'Ance; Jerod R. Patron, Lima, Peru; Russell R. Trengove, Lake Linden; Robert R. Van Valkenburg, Wenatchee, Wash.; Harry Vivian, Calumet; Ralph R. Riggins, Indiana, Pa.; Joseph R. Wilkinson, Alphena; Richard G. Zimmer, Helena, Mont.

James Forrester, of Duquesne, Ill., a member of the Illinois State Mining Board, has been appointed superintendent of the Ziegler District Collieries Co.'s properties near Christopher, Ill.

State Mine Inspector William Walters has moved his headquarters from Midland to Frostburg, Md.

Andrew A. Bruch, manager of sales of the S. Flory Mfg. Co., of Bangor, Pa., died on October 20. Mr. Bruch was connected with the Flory company from its beginning and was an important factor in the development of its business. His ability and personality were such that he was as highly regarded by the customers with whom he was thrown in contact, as he was by his business associates.

It has been announced that J. B. Connell has resigned his position as superintendent of the Morea, Pa., and of the Beaver Brook store (Chas. M. Dodson & Co.) and has been appointed general superintendent of the mining operations of the Dodson Coal Co., Morea, and of Chas. M. Dodson & Co., at Beaver Brook, under T. M. Dodson, vice-president. William A. McGinley remains as superintendent of Morea colliery, and William C. Roth has been appointed superintendent of Beaver Brook. P. J. Malloy has been appointed purchasing agent of the two companies.

F. J. Fohs, of the firm Fohs & Gardner, Tulsa, Okla., is in Wyoming studying the oil possibilities for that state.

Col. R. A. Phillips, general manager of the coal interests of the Lackawanna, emphatically denies the statement that he is an applicant to succeed James E. Roderick, Chief of the Department of Mines of Pennsylvania.

John Whelan, Jr., formerly with M. A. Hanna & Co., of Cleveland, and general superintendent of the Masillon Coal Mining Co., Masillon, Ohio, has resigned his position with those companies to become vice-president and general manager of the Copen Creek Coal Co. at Webster, W. Va.

On November 7, while at the ship yards at Holt, Ala., Erskine Ramsay, vice-president of the Pratt Consolidated Coal Co., was seriously injured. Mr. Ramsay was in the first barge of the company which was being launched. As the boat struck the water the upward movement threw Mr. Ramsay against a beam, causing concussion of the brain. He will recover.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Cleaning of Blast Furnace Gases, by Frederick H. Wagner, M. E. Published by McGraw-Hill Book Co. 160 pages, illustrated, $2 net.

It is a well-known fact that the gas as it leaves the blast furnace usually contains from 3 to 10 grains of dust per cubic foot of dry gas, and in case of any leak this percentage is at times materially increased; this dust being of a gritty nature, since it is composed of particles of coke, limestone, and ore, has a bad effect in hot-blast stoves as well as in boiler furnaces and in engine cylinders.

This condition then necessarily requires a certain degree of cleaning, that degree being dependent on the composition of the gas, which is due to the blast-furnace mixture.

It is to this end the book is written and it gives in interesting detail the various methods used and their effectiveness.

West Virginia Geological Survey.—"Detailed Report on Preston County," issued under date of September 1, 1914, contains 566 pages +XIX of introductory matter, is illustrated with 49 half-tone plates and 10 figures in the text; accompanying it is a case of 3 maps covering the soils, topography, and geology of the country separately. In addition to the detailed description of all the geologic formations exposed in Preston County, the geologic map gives the structural contours and outcrop of the Upper Freeport coal, the most important mineral horizon of the area in question. The soil and topographic maps will also prove of great value to every interest including agriculture, road improvement, water resources, etc. Price, with case of maps, delivery charges paid by the Survey, $2, but for combination price with other publications, write to the W. Va. Geological Survey, P. O. Box 448, Morgantown, W. Va. Extra copies of the Topographic map 50 cents each; and of the Geologic map, $1 each.

The Belger Dust-Laying Fluid

The use of a fluid composed essentially of glue and calcium chloride in solution, for laying coal dust, has been tested on a commercial scale at a Newcastle colliery, in England, with, it is affirmed, effective results. The liquid is placed in a specially designed 100-gallon tank, mounted on wheels, and is applied in the form of spray at a cost of about 50 cents per yard per annum. One application suffices for 3 months. Besides successfully accomplishing the primary purpose of laying dust, the liquid acts also as a preservative of timber.

Removal

The Colorado Scientific Society has removed from 418 Boston Building, to the Colorado State Museum, Fourteenth Avenue and Sherman Street, Denver, Colo.

It is said that in 1786 Lord Dundonald had the gas from his coke ovens burned at the end of a long pipe for the purpose of amusing his friends.

WITH THE EDITORS

WHILE as Americans, and citizens of a neutral nation, we have undoubted right to sympathize with such belligerent nations of Europe as we see fit, our nation is and will remain neutral as long as American rights are not infringed. It is too much to expect Americans, as individuals, to refrain from discussing war matters, and incidentally expressing their views as to the justice of the action of the several nations involved. As such discussion, however, is of no profit to us as individuals, and may, if carried too far, be troublesome to our national government in its neutrality policy, we must commend the spirit, if not the language of the placard, displayed in a prominent New York business house, which reads:

"If you want to fight, go to Europe.
If you want to talk war, go to H—."

Royalton Explosion

ON ANOTHER page will be found an account of the Royalton, Ill., mine explosion. The consensus of opinion is that it was a gas explosion originally, and with that we agree; however, the percussion traveled 400 feet against the air-current and piled up a trip of cars which are said to have prevented the explosion extending in that direction. This would indicate that it was more than a gas explosion, unless the fourth West entry contained gas or the force of the explosion in that direction was increased by dust or by an explosion of powder, or both.

It used to be said that an explosion of gas traveled in the direction of the incoming air, but a little thought will show that unless there is something for the flame of an explosion to feed on it must soon die out, therefore if the explosion travels against the air there must be either gas or dust to keep it going.

Gas naturally is swept by the air-current into the return, and the gas explosion will take that course and be most severe in this direction, as in this case, because the flame has something to feed on as it moves toward the outlet. As the flame and force of the explosion stopped near the shafts, we are again led to assume that the mine was not a dusty one and that most of the explosion and its effect were due to gas. This conclusion is based on the findings, on the fact that the coal was not friable, and because a watering car was used to keep down what little dust was made in the haulage roads. Mine Manager James Brown knew his mine, and directly after reversing the fan he entered the mine to warn men that the ventilating current had been reversed. As it was, 38 men rushed to the bottom of the air-shaft and 58 more were headed that way when he called them back. Mr. Brown's method was heroic, but we can make a guess that the results would have been disastrous had he been unable to enter the mine and inform the men of the conditions, as would probably have been the case had the explosion been due to dust.

The method of circulating the air, and the system of mining followed, undoubtedly had much to do with preserving the lives of the majority of the men in the mine at the time of accident, for the different sections were practically separated and each supplied with its individual air split.

Reviewing the more recent explosions, we find that the Jed, the Bottom Creek, the Cincinnati, the Eccles, the Mulga, and the Franklin, were credited with being exploded by naked lights, from which we draw the inference that to have safety in bituminous mines below water level, only safety lamps should be used. The Eccles management took this common-sense view of the matter and now work their mines with electric and safety lamps. This company's mines give off little gas, but the management recognize that natural causes may at any time convert a comparatively safe mine into an unsafe one, and the company has had all the experience in that line it desires.

This is a safe rule for every coal mining company to follow whose mines are worked below water level. Mr. Oscar Cartlidge, the manager of the Illinois Mine Rescue Commission, is to be congratulated on the way his Benton corps was handled. Mr. Cartlidge did not wait to take the Rescue car at Benton, but moved his men by automobile, thus saving valuable time; for, as shown in this case, the time to do most effective life saving is shortly after the explosion.

Coal Land Litigation

AFTER protracted negotiations, the Department of Justice, with the concurrence of the Department of the Interior, has come to an agreement with the American Smelting and Refining Co. for the settlement of important litigation concerning coal land in Colorado. When the Interior Department discovered that the patents had been illegally obtained the 6-year period of the statute of limitations applicable to suits to cancel patents had expired, and the lands near Aguilar had apparently been conveyed to a bona fide purchaser. Nevertheless a suit in equity was begun to cancel the patents covering the Cokedale lands and an action at

law to recover the value of the Aguilar lands alleged to be upward of $1,000,000. In both of these proceedings the smelting company was made defendant.

"In the first case Judge Lewis, of the United States District Court for Colorado, held that the cause of action was barred by the statute of limitations. Upon appeal to the Circuit Court of Appeals this ruling was reversed on the ground that the period of limitation in such cases does not begin to run until the cause of action has been discovered by the plaintiff.

"The result of the agreement reached will be to restore to the United States full title to all lands in controversy with the exception of about 220 acres of the Cokedale lands and 320 acres of the tract near Aguilar.

"The result of the agreement leaves 220 acres at Cokedale to support improvements worth many hundreds of thousands of dollars, consisting of coke ovens, etc., which have been long erected thereon and which are necessary in the industry of mining and coking coal taken under a lease from adjacent lands owned by the state of Colorado. This small tract, however, will be paid for by the company at its present value to be estimated by the Geological Survey.

"In fairness to the company it should be added that since the time when the proposition of settlement was first broached it has afforded to the agents of the Government full access to the properties in question and to its records of mining operations."

The above was the statement made by the Department of Justice at Washington on November 1. By this agreement the United States Government regained possession of practically 3,494 acres of coal lands in Colorado, and receives in addition about $100,000 in payment for the coal mined out on that property.

An unwarranted criticism of the Guggenheim interests will naturally arise on noting the fact that the patents had been illegally obtained. But all the companies to whom patents were granted were bona fide corporations and were absorbed by the American Smelting and Refining Co. in a legitimate manner. The last paragraph of the Department's statement shows how willing the company was to have the tangled affair straightened out, and it is with gratification we note the Government acknowledging the courtesies of the defendant company.

Care of Mine Timber

IN THE July, 1912, issue of Mines and Minerals, now The Colliery Engineer, there was an article on page 706, relative to the experimental work which was being done by the Delaware, Lackawanna & Western Railroad Co. in timber treatment tests. In a certain place in one of the Kingston mines where timbers lasted only about 6 months, the pit timbers were replaced with creosoted loblolly pine, and in between these timber sets were placed others of the same kind of wood that had been peeled and seasoned. In the same locality loblolly pine sticks treated with lime were placed so that they would be subject to the same general conditions. These timbers lasted for about 5 years and all seemed to be sound. At the end of the sixth year, however, the lime treated sticks were decayed to such an extent that they were replaced with timber treated with creosote and chloride of zinc. The simple lime treatment which increased the life of the timber from 6 months to 6 years shows how necessary it is to care for mine timber and the economy of so doing, for the creosoted timbers are practically sound after 7 years.

The Locomotive Centennial

THE mining industry has been the incentive to the the most useful inventions civilized nations enjoy. The steam engine was invented by Watt to pump out mines; next it was improved to hoist mineral, and then modified to haul coal. Dating from the time, 1814, that George Stephenson made his first locomotive, writers have considered him the originator, and that 1914 was the centennial of the machine. According to Robert L. Galloway in his Annals of Coal Mining: "The early history of steam locomotion has been distorted in an extraordinary manner by the biographers and partisans of different engineers. Notwithstanding the extravagant claims which have been put forward on behalf of Hedley and George Stephenson as inventors of the locomotive, it may truly be stated that neither of them contributed anything of note to the invention in addition to what Trevithick (1802) and Blenkinsop (1812) had done." The idea of attaching two cylinders to one pair of wheels, by Robert Wilson, and the introduction of the steam blast in the smoke stack, by Timothy Hackworth, in 1826, seem to have perfected the locomotive and made it a success. It would seem, therefore, that 1804 would be the locomotive's centennial, as in February that year Trevithick's patent "iron cart horse" on a wager of 500 guineas drew 10 tons of iron and 70 men 9 miles. On the third journey it went off the road and broke both axles. The difficulties attendant on this kind of transportation were that the cast-iron rails broke, the hooks between the wagons gave way frequently, and bolts broke here and there. The distance on the first trip, however, was negotiated in 4 hours and 5 minutes, although several trees had to be cut down and stones removed. John Blenkinsop obtained a patent in 1811 for using a rack-rail to prevent the locomotive wheels slipping. He also employed two steam engines, to produce a steady action without a flywheel, and a wrought-iron boiler. His locomotive commenced work running from Middleton colliery to Leeds in June, 1812. The records of this locomotive state that it drew 27 wagons weighing 94 tons on a level at the rate of 3½ miles per hour, but when lightly loaded could go 10 miles per hour. Stephenson commenced work on his first locomotive in 1814, but he is said not to have been

successful until he adopted Wilson's and Hackworth's ideas, with the multitubular boiler, which were applied to the "Rocket" after the year 1826.

Government Ownership

THE National Civic Federation will hold its fifteenth annual session at the Hotel Astor, December 4 and 5, at which time there will be a discussion on "How Far Shall Government Effort Supplant Private Enterprise?" In recent years the idea that this government is a paternal institution seems to have gained momentum until now proposals are being advanced to have the Government take over coal mines, packing houses, flour mills, to purchase ships for transportation purposes, to establish depots to sell food to the people at cost; to construct municipal dwellings; to enter into a large program of road building and reclamation schemes to furnish employment for those out of work. In addition to this a new stimulus has also been given to those who advocate the Federal Government taking over the railroad, telegraph, and telephone systems, and municipalities taking over the gas, electric light, and street railways.

Already government war risk marine insurance is an accomplished fact. Proposals for guaranteeing the price of silver, cotton, wheat, tobacco, canned salmon, and naval supplies, appeared suddenly in Congress. Naturally enough the apple growers' association also began agitating for the Government to take care of the apple crop—all "on account of the war." Mother Jones and some others want the United States Government to work the coal mines of Colorado, in order to help a couple of thousand coal mine strikers get jobs from which they discharged themselves.

We are thoroughly opposed to paternalism, it not being the object of this Government; further, from the way politicians conduct governmental business we are convinced that the public will have to pay more in the end for any service rendered than it would if the same service were carried on by private interests. Again, if the national government, a state, or a municipality, goes into manufacturing, mining, or the ownership of public utilities, the army of employes, to keep their jobs, would have to be subservient to the party in power, and a political bureaucracy would be established which would be difficult to change.

Again, under such circumstances there would be strong likelihood of promotions being made on account of political influence instead of superior technical or business ability, and in the end there would be a National Tammany Hall which would result in increased cost of production, and less safety to the health and lives of the workingmen. This condition of affairs would bring on rebellion and, if not disruption, a mighty civil war.

The government is a corporation founded on a charter (Bill of Rights) with a Constitution, in which nowhere will be found any clause permitting it to enter into general business or manufacturing. It has the right to regulate interstate business and has certain police rights, but aside from these, its sole concern is to make laws and administer the public business for the benefit of the people as a whole. It has no right to confiscate land or chattels, even for treason, let alone the coal mines of Colorado, where miners receive over $4 per diem and draw over 80 per cent. of it in cash. President Wilson is evidently trying to deal fairly with the miners and operators, and while he sent troops to Colorado to preserve peace, he hesitates to take charge of the Colorado mines, for he does not find that he has any legal right to do so, particularly since the 10,000 miners at work are satisfied and the people of Colorado are not suffering for fuel.

Reading Schools Open

The first meeting to organize the 1914-1915 classes of the Philadelphia & Reading Coal and Iron Co. schools was held October 1. The textbooks, instruction and drawing instruments for the classes in Pottsville will be furnished free of charge by the company as in the past. These classes are under the direction of William H. Lesser, mechanical engineer, who teaches the mining and mechanical drawing and has an assistant to teach the shop class. Every man in the class last year received either a mine foreman's or assistant mine foreman's certificate from the state.

The first of these classes was started in 1907. An instruction book entitled "Shop Class Problems" was especially prepared by Mr. Lesser for the shop class. It deals with the essentials without any frills, is couched in simple language, and has been in successful use since 1912. Mr. Lesser has also devised a practical loose-leaf system that includes the elements of the problems given in many state examination papers for the use of the mining class.

The schools at Mahanoy City, Minersville, and Shenandoah are conducted with International Correspondence School textbooks, and under the supervision of the Philadelphia & Reading Coal and Iron Co. officials. The other Reading school in the southern anthracite region is that at Shamokin, and is under the supervision of the local public school board.

This system of education, enabling the students to take the next step up and increase both their usefulness and incomes, was one of the many helpful movements sfarted by President W. J. Richards. It is interesting to note that the first mining class in the anthracite region of Pennsylvania was started by Eckley B. Coxe at Drifton, Pa., 34 years ago.—*P. & B.*

Answers to Examination Questions

Questions Selected From Those Asked at an Examination for Mine Foreman, Held in Price, Utah, September 15 and 16, 1914

(Continued from November issue)

Ques. 1.—What four principal things are bandages used for?

Ans.—Bandages are used (*a*) to keep dressings in place; (*b*) to fix splints; (*c*) to stop bleeding; (*d*) as slings to support a broken limb.

Ques. 2.—Name the different kinds of bandages generally used in first aid to the injured work.

Ans.—The bandages commonly available for first-aid work are the roller and the triangular, but these may be combined to form a third class of special bandages. The roller bandages are best adapted to placing over a wound or to hold some liquid dressing. The triangular bandages have a much greater range of usefulness than the roller bandages, and the special bandages are, as the name indicates, used in the unusual cases where the standard kinds are not suitable.

Ques. 3.—Describe the Red Cross first-aid outfit?

Ans.—First-aid outfits come in various sizes and their contents naturally vary. The outfit generally contains the following materials: absorbent lint, cotton, and gauze; cotton and gauze roller bandages 2 inches and 2½ inches wide; picric acid gauze; adhesive plaster; triangular bandages; safety pins; carbolated vaseline; scissors; tweezers; splints; tourniquet; etc.; and a book of instructions. Rarely, stimulants like aromatic spirits of ammonia are included in the first-aid outfit.

Ques. 4.—Name some stimulants you would give and state how you would use them.

Ans.—Stimulants are applied in two general ways; externally and internally. The external stimulants are heat and cold; the internal, liquids of various kinds.

Heat is best applied through the medium of hot water contained in an ordinary hot-water bottle or, if such is not to be had, in glass bottles or jars. When none of these are to had, hot bricks or stones, wrapped in one or more layers of cloth or paper so as not to burn the patient, may be used. In other cases, bandages soaked in hot water are applied.

The use of cold as a stimulant is generally limited to starting breathing which was stopped or to strengthen it if weak, by sprinkling cold water on the face, chest, and abdomen.

Internal stimulants should be given hot, when possible, and consist of tea coffee, and wine, brandy, whisky, or grain alcohol; the last three being given in doses of two or three teaspoonfuls after dilution with water to one-half to two-thirds strength. In place of alcoholic stimulants it is recommended to give from 20 drops to 30 drops of aromatic spirits of ammonia in one-third of a glass of hot water.

Ques. 5.—(*a*) What is shock? (*b*) When does shock occur? (*c*) Describe treatment of shock.

Ans.—(*a*) Shock is a depression of the nervous system of varying degrees of intensity, and is commonly accompanied by stupor or unconsciousness. (*b*) Shock is due to a severe injury arising from any cause of accident around the mines. (*c*) The patient should be placed on the back with the head low. If able to swallow, give him liquid stimulants as explained in the preceding question. If whisky is used, give but one large drink. Cover the patient with blankets or coats and keep him warm. Stimulate externally by applying hot-water bottles, bricks, etc., as explained before. The legs and arms may be rubbed upwards toward the body to quicken circulation.

Ques. 6.—How would you prevent a simple fracture from becoming a compound one?

Ans.—A simple fracture becomes a compound one when the jagged edges of the broken bone pierce the flesh and protrude through the skin; hence, all possible care must be taken to prevent this. The patient should be placed in a comfortable position, the broken bone being supported on each side of the break while he is being moved. The bone should then be set by drawing it into its natural position and held in place by splints and bandages. It is well not to remove the clothing if the nature of the injury can be determined without so doing; if the clothing must be removed, cut it at the seams so that it may be folded aside over the broken bone. If there is shock, treat it as explained.

Ques. 7.—How would you know whether bleeding came from an artery, a vein, or capillary?

Ans.—When an artery is severed, the blood is expelled in jets and is bright red in color; blood from a severed vein is dark blue and issues as a steady flow; in capillary bleeding, the blood is a brick red and oozes from the wound.

Ques. 8.—How would you treat a burn due to electricity?

Ans.—Burns due to electricity are treated in the same way as those caused by fire, the nature of the treatment depending upon the depth of

the injury. First-aid treatment is generally limited to excluding the air with a thin paste made of bicarbonate of soda, starch, or flour, and water, which is spread over the burned part. More of the paste is spread on a cloth which is applied to the burn, and is held in place by a bandage. If bicarbonate of soda is not available, vaseline, either plain or carbolated, olive or castor oil or lard, may be used. If the burn is very deep it may have to be treated like an open wound; in some cases the treatment for shock will be necessary.

Ques. 9.—How would you treat a person overcome with noxious gases?

Ans.—Get the person into fresh air, loosen the clothing about the chest and abdomen, perform artificial respiration, use the breathing apparatus, if necessary, and give stimulants as soon as the patient can swallow.

Ques. 10.—Describe briefly the Sylvester and Schaefer methods of artificial respiration.

Ans.—In the Sylvester method the patient is placed on his back with a rolled up coat under his shoulders. The tongue is drawn forwards and held clear of the mouth with a bandage, rubber band, or clamp. Clean obstructions such as froth, saliva, or mucus from the mouth. Kneeling just above the patient's head, catch both his arms just below the elbow and draw them outward and upward gently and steadily as far as they will go above the head, and hold them so for about 2 seconds. Bring the arms down till the elbows press against the chest, and hold them so for about 2 seconds. Repeat these motions about 15 times a minute, until the patient begins to breathe.

In the Schaefer method, the patient is placed face down with his head turned to one side so that his mouth and nose do not touch the ground. Kneel astride of the patient's thighs, facing his head. Raise the clothing so that the back is bare. Place the outspread hands on the back, with thumbs nearly parallel to the fingers, so that the little finger curls over the end of the twelfth rib. Hold the arms straight and bring your weight upon the patient by bringing your body and shoulders forward gradually until at the end of 3 seconds the vertical pressure upon the lower ribs of the patient is felt to be heavy enough to compress the parts; then suddenly release your weight. Pressure and release of pressure should occupy about 5 seconds.

Either method of treatment should be continued for 2 hours or more. As soon as the patient begins to breathe, the limbs may be well rubbed upward toward the heart. After regular breathing is restored he may be put to bed and stimulated by the application of hot-water bottles, and, internally, by hot drinks as soon as in a condition to swallow.

Ques. 11.—Name the different kinds of openings of coal mines.

Ans.—When the coal seam outcrops it may be opened by a drift or a slope, driven upon the coal; if it does not outcrop, it may be opened by a shaft, or a rock slope, driven through the rock. In rare cases a rock tunnel is driven into a hillside and across the measures to reach a pitching seam which does not outcrop upon the property.

Ques. 12.—Describe briefly: (*a*) longwall advancing; (*b*) longwall retreating.

Ans.—(*a*) In longwall advancing, a pillar of coal is commonly left around the foot of the shaft. Beyond the shaft pillar the coal is opened out on both sides in a continuous face. As this face advances the roof is allowed to fall behind, a main road or roads being maintained through the gob thus formed by building pack walls of rock along their sides. As the face extends further from the main road, diagonal roads making an angle of about 45 degrees with the main road and from 200 to 300 feet apart, are used to make a shorter haul from the face to the main entry. From these diagonal roads are maintained rooms which are driven parallel to the main road and are spaced from 25 to 50 feet apart. The sides of the diagonal roads and rooms are, like those of the main road, supported by solidly built packwalls of rock. The coal is brought down by undercutting the face in one continuous line. When the undercutting is completed, the sprags of coal or timber are cut out, and the weight of the overlying rock is sufficient to bring down the coal in large lumps.

(*b*) In longwall retreating, one or more main roads are driven from the foot of the shaft to the outer boundary of the property, at which point the longwall face is started. As the face of the workings begins at the property line, it is apparent that it is not necessary to maintain any roads in the gob; all the roads are in solid coal. In other ways, the system is the same as longwall advancing.

Ques. 13.—If you had charge of a mine, the workings of which were approaching an old mine to the rise, full of water, what precautions would you adopt?

Ans.—Have the survey of the workings brought up to date and plat them so that the thickness of the pillar between the two mines is known. If it is not necessary to tap and drain the old workings, a barrier pillar should be left between the two mines. There are numerous rules for determining the thickness of this pillar. One used in the bituminous regions of Pennsylvania provides that there shall be 1 foot of thickness of pillar for each 1.25 feet of head of water. In the anthracite regions of the same state, the thickness of the seam is brought into the calculation, and the thickness of the pillar is made equal to (thickness of coal $\times$ 1 per cent. of head of water) + (thickness of coal $\times$ 5).

Assuming a seam 8 feet thick, and a head of water of 375 feet, the first rule calls for a pillar $375 \div 1.25 = 300$ feet thick. The second rule indicates that the pillar should be $(8 \times .01 \times 375) + (8 \times 5) = 30 + 40 = 70$ feet.

If it is desired to tap and drain the old workings, the advanced workings should be suspended except one place which should be narrowed down to heading width. Bore holes should be driven ahead in each corner of the heading with flanking holes on each side, which holes should extend 20 feet or more into the solid. Fre-

quently, the approach of the old workings will be indicated by the seepage of water along the roof, floor, joints, or cracks in the coal; or the coal may begin to turn red or brown owing to the deposit of iron oxide from the water in the old mine.

Ques. 14.—When the fire-boss reports, in his record book, certain dangers that he has discovered during his examination, what then do you understand is your duty as foreman?

Ans.—The removal of the dangers should be ordered, and the foreman should see that his instructions are obeyed.

Ques. 15.—(*a*) How would you proceed to examine the roof and sides on the haulage roads, traveling ways, and working faces? (*b*) Can you always rely on the sound produced by tapping them? If not, why?

Ans.—(*a*) In event of there being excessive weight upon the pillars, there will commonly be a bowing out of the coal on the sides, followed by its dropping away from the rib and falling in the gutter beside the track. In event of the rib appearing in good condition, it is well to sound it from place to place with a pick, a drummy sound commonly indicating that the coal at the place struck is about to spall off, and, consequently, that there is too great weight on the pillars.

More care and skill must be exercised in examining the roof than the sides. Sounding is generally relied upon to locate loose places where the roof is liable to fall, and a careful watch must be kept for slips or cracks, particularly those which run parallel to the face. Where the places are timbered, the timbering should be examined for its soundness as well as for any undue weight coming upon it.

(*b*) A hollow, drummy sound indicates that the rock at the point struck has broken away from the main mass. It does not follow, however, that the place is unsafe, as the loose rock may be properly timbered at the time. Also, the slip may not be an extensive one, and if the roof rock is tough the loose portion will project beyond the pillar and be supported by it in a manner similar to a beam fixed in a wall. A drummy rib does not indicate that, as a whole, it is unsafe, as the sounding may have been made at a place where, locally, a vertical joint happens to be more or less open, the pillar at other places being in a safe condition. It should be noted that, if the rock which is detached from the main part of the roof, is very thick, it will sound solid when struck with a pick or hammer.

Ques. 16.—What, in your opinion, are the principal causes of the greatest number of fatalities in our mines? Give a list of six causes, in the order in which you have seen them occur.

Ans.—This question may be answered as a whole, and from the standpoint of the candidates personal experience. In the United States at large, the order of the causes of mine accidents is, falls of roof and coal; mine cars and locomotives; gas and coal-dust explosions; handling explosives; electricity; mine fires; falling down shafts; and other causes. Of these six causes of accident, falls of roof and coal are responsible for very nearly one-half of the deaths; haulage accidents and explosions cause about an equal number of deaths and a trifle more than one-quarter of the total; the other three causes bringing about a little less than one-quarter of the deaths.

Ques. 17.—State briefly, as foreman, how you would try to prevent accidents under these six heads.

Ans.—Since between one-half and three-quarters of all the accidents are caused by the carelessness or ignorance (chiefly the first) of men themselves, it would seem that properly enforced instructions to the careless men and the education of the ignorant, would materially reduce the number of accidents from all causes. While the mine foreman is supposed to caution and instruct the men, he cannot be with them constantly, and his best course is to attempt to guard the men against the results of their own carelessness.

Falls of coal may be prevented by properly spragging the coal while it is being undercut either by machine or by hand. Falls of roof may be lessened by watching the top rock constantly, taking it down as soon as any weakness is detected, or, if this is not practicable, by immediately supporting it with timber. Accidents from mine cars and motors may be lessened by providing distinct traveling ways for the men, or, where traveling on a motor road cannot be avoided, by providing ample width on one side between the rail and rib, with the necessary refuge holes at frequent and regular intervals. Also, unauthorized persons should not be allowed on any moving trip, and all trips should be supplied with the necessary lights and warning signals. Gas explosions may be prevented by properly splitting the air and carrying it to the face in sufficient quantity, and by using safety or portable electric lamps. Dust explosions may be prevented by guarding against the production of dust, removing such as is made; watering the roof, and ribs of the headings and rooms or by treating them with shale dust; by the employment of permissible powder used in minimum quantities in well-balanced holes after the seam is undercut, etc. Explosives should be carried into the mine in quantities only sufficient for the day's work. They should be used in holes of less depth than that of the undercut, and the holes should be properly balanced, clay or shale dust being used for tamping. The holes had better be fired with a battery, preferably by regular shot firers and after the men have left the mine. Powder should not be handled near an open light and metal cannisters should not be carried on the shoulder while walking near wires carrying an electric current. Holes, which have missed fire, should not be approached for five or ten minutes, and no attempt should be made to draw the charge from a missed shot. Electric accidents may be lessened by carrying any high-voltage feed-wires, which should be carefully insulated, into the mine through some other than a traveling road. For use in motors and mining machines, the voltage should be as

low as possible, and all wires and other parts carrying current should be insulated and, where necessary, properly grounded. Along the haulage road, the trolley wire should be placed in an inverted wooden trough with sides at least 3 inches deep. Mine fires may be lessened by loadout all slack and other carbonaceous material and hauling it from the mine. A careful watch should be kept upon the gob and abandoned workings for evidences of spontaneous combustion in its early stages. Accumulations of shavings, paper, etc., should not be allowed where they may be ignited from a match, old lamp wick, etc. Electric wires placed near or passing through woodwork should be carefully insulated. After shot firing an examination of each working place should be made for evidences of fire. Accidents in shafts may be diminished by having the proper gates at the head and foot of the shaft, by proper hoisting-rope inspection, and by providing devices to prevent overwinding, safety catches, etc.

This is a very comprehensive question, and a large volume might be written on the subject of mine accidents and their prevention.

Cooperation of Colleges

In accordance with the agreements for cooperation between the Massachusetts Institute of Technology and Harvard University, six Harvard professors are to be added to the instructing staff of the Mining Department of the Institute this year. Their names and departments are as follows: Henry Lloyd Smyth, A. B., C. E., Professor of Mining and Metallurgy; Edward Dyer Peters, M. D., Gordon McKay Professor of Metallurgy; Albert Sauveur, S. B., Professor of Metallurgy and Metallography; George Sharpe Raymer, A. B., M. E., Assistant Professor of Mining; Charles Henry White, S. B., A. M., Assistant Professor of Mining and Metallurgy; Louis Caryl Graton, S. B., Professor of Mining Geology.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Geological

Editor The Colliery Engineer:

SIR:—Is it not peculiar that we should find massive pyrite as much as 6 feet thick, within 3,000 feet above a deposit of an iron carbonate from 12 to 16 inches thick? Is not this a question for the geologists to discuss and explain how it could occur? And why these deposits are not more persistent in other fields?

J. E. BUTLER

Stearns, Ky.

Shot Ignition by Electric Machine

Editor The Colliery Engineer:

SIR:—I would like to ask a question to be answered through your paper.

If a shot is tamped with black powder and the needle is left in the powder, is there any danger of the shot igniting while an electric mining machine is cutting the place and the frame of the machine is charged with electricity?

C. B.

Worden, Ill.

Bolts for Shaft Couplings

Editor The Colliery Engineer:

SIR:—Please give me a safe rule for finding the diameter of bolts when coupling hollow shafts together, giving an example, and oblige,

J. K. RILEY

Pittsburg, Pa.

The rule for determining the size of the bolts for couplings varies with the kind of shaft used.

For solid shafts $d=\frac{1}{2}\sqrt{\frac{D^3}{nh}}$

For hollow shafts $d=\frac{1}{2}\sqrt{\frac{D^3-\frac{d_1^4}{D}}{nh}}$

d = diameter of bolts desired;
D = diameter of shaft or outside diameter of a hollow shaft;
d_1 = inside diameter of hollow shaft;
n = number of bolts to be used;
h = the distance of the center of a bolt from the axis of a shaft.

Take for example a hollow shaft 20 inches in outside and 12 inches in inside diameter to be coupled with 16 bolts placed with their centers 14 inches from the axis of the shaft. To find the diameter of the bolts,

$$d=\frac{1}{2}\sqrt{\frac{20^3-\frac{12^4}{20}}{16\times 14}}=\frac{1}{2}\sqrt{\frac{160,000-20,736}{20\times 16\times 14}}$$
$$=\sqrt{7.827}=2.8 \text{ inches}$$

diameter of bolts to be used.

Conversely, if the size of bolts has already been decided upon, the number to be used can be calculated from the same formula by solving for n.

Size of Pipe

Editor The Colliery Engineer:

SIR:—I have had considerable difficulty in ascertaining the proper sized pipes for some of our water lines at the different mines in this district, and cannot find a reliable formula for determining the diameter of the pipe to be used.

SUPERINTENDENT

Welch, W. Va.

On page 148 of the Coal and Metal Miners' Pocketbook are several good formulas for determining the diameter of pipes. Another one frequently used is by Merriman, and is

$$d=.4789\left[(1.5\,d+f\,l)\frac{q^2}{h}\right]^{\frac{1}{5}}$$

To show the use of these formulas, find the diameter of a pipe delivering 500 gallons per second, its length

being 4,500 feet with a pressure equal to a 24-foot head of water.

To use the above formula for computing the diameter, h, l, and d are in feet and q is in cubic feet per second. Then

$$q=\frac{500}{7.481}=66.84 \text{ cubic feet per second}$$

assume the friction factor $f=.02$ or

$$d=.4789\left[(1.5d+.02\times 4{,}500)\frac{66.84^2}{24}\right]^{\frac{1}{5}}$$

but, for all practical purposes the d on the right-hand side of the equation may be neglected, and

$$d=.4789\left(\frac{.02\times 4{,}500\times 66.84}{24}\right)^{\frac{1}{5}}$$
$$=3.35 \text{ feet.}$$

Washery Efficiency

Editor The Colliery Engineer:

Sir:—Your request for a discussion of Mr. A. D. MacFarlane's paper on "Washery Efficiency" received.

We have never gone into the matter of determining washer loss from the proximate analysis of the raw coal, washed coal, and refuse, nor from the British thermal unit value of these three products, as suggested by your correspondents. I do not feel that there is any practical value in such a determination, for the reason that the separation of the coal and refuse in a washery is merely a specific gravity separation. It so happens that most of the material which is undesirable in coal is heavier than the coal and can be separated in this way. There is considerable matter in the so-called refuse which contains heat units and there is necessarily a greater percentage of ash on the average in the washed coal than there would be in a particular piece of coal which was selected for analysis.

The writer believes that the only fair means of comparison is between a laboratory specific gravity separation and the actual separation in the washery itself. So far as determining the efficiency of a washery, the only fair way is to figure how much better price can be obtained for the washed coal than for the unwashed, considering of course the amount of the original raw coal which would be thrown away in the refuse pile. There is no other efficiency calculation that appeals to the coal operator.

L. S. Richards,
Engineer, Link-Belt Co.

Ventilation

Editor The Colliery Engineer:

Sir:—Please solve the following conditions:

The temperature of the intake current of a mine is 35° F. at a point along the airway where the anemometer gives a reading of 2,820 feet in 3 minutes. The airway at that point being $8\frac{1}{3}$ feet wide and $5\frac{3}{4}$ feet high.

(*a*) What is the quantity of air passing into the mine per minute?

(*b*) Assuming the mine to be ventilated by an exhaust fan, what volume of air would be going up the upcast shaft if the temperature there is 65° F., and the water gauge gives a reading of 3.4 inches, assume the barometric pressure at the foot of the downcast shaft is 29.35 inches and the coal seam level?

C. T. Atkins
Marceline, Mo.

(*a*) If the intake air has a speed of 2,820 feet in 3 minutes, it means a velocity of $\frac{2{,}820}{3}=940$ feet per minute.

The volume of air at any point $=a\,v$.

$a=$ the sectional area at that point;
$=8\frac{1}{3}\times 5\frac{3}{4}=47.917$ square feet;
$v=$ the velocity $=940$ feet per minute, therefore,
volume $=940\times 47.917=45{,}041.98$ cubic feet per minute traveling along the airway at that point per minute.

(*b*) The barometer and water gauge readings may be neglected, not that pressure does not affect the volume, but because there is no ventilating pressure given at the intake. The barometer is the same at both shafts.

Then, with the data given, the volume will increase according to its absolute temperature.

The absolute temperature at the foot of the intake shaft is $459°+35°=494°$ F.

The absolute temperature at the foot of the upcast is $459°+65°=524°$ F.

Then:

$$459 : 524 :: 45{,}041.98 : x$$
$$x=\frac{524\times 45{,}041.98}{459}=51{,}500$$ (approximately) cubic feet per minute.

Steel

Editor The Colliery Engineer:

Sir:—Recently in one of our mines three I beams were broken by the weight of the roof. The fracture was so dark that the steel seemed to have almost too much carbon. This, of course, would mean nearly wrought iron, which would bend. Please give me some information relative to the part carbon plays in the formation of good steel. J. D. K.

Centralia, Ill.

Good steel varies in carbon content from .10 up to 1.50 per cent. It is malleable and temperable, and has a specific gravity of 7.8. The physical properties of steel naturally depend upon its chemical composition as well as its method of manufacture. Carbon is the one dominant element in regard to strength and ultimate elongation. Within a reasonable limit, the greater the percentage of carbon present the greater the strength and the less the ultimate elongation.

Blasting Frozen Bulk Freight in Cars

Have you ever been perplexed in trying to unload a carload of frozen bulk freight and how to do it economically and expeditiously, such as sand, clay, rock ballast, ore, or any other such material? Dynamite in small charges can be used to good advantage in such work and without danger if handled correctly.

Use a slow-acting dynamite such as Red Cross Extra, 20 per cent. strength, in charges of from one-fourth to one-half of an $1\frac{1}{4}''\times 8''$ cartridge. Make a hole in the material with a crowbar or auger according to the material to be loosened, but do not have any part of the charge of explosive nearer the side or bottom of the car than 2 or 3 feet. Tamp hole when loaded, and explode charge with cap and fuse.

NEW MINING MACHINERY

Long-Distance Recording System

A new electrical long-distance transmitting indicating and recording system is being placed on the market by the Bristol Company, Waterbury, Conn. Bristol recording instruments when equipped with Bards patent long-distance induction-balance movements are capable of producing automatic and continuous records of pressure, liquid levels, temperatures, mechanical motions, etc., at long distances, even many miles from points at which the transmitters are located.

Fig. 1 shows the transmitting indicator for installation at the point where the pressure or temperature, etc., is measured, and the receiving recorder which is installed where it is desired to have the record produced.

The two instruments are shown connected by three wires, one of which is connected to a source of alternating current, as for instance, a lighting circuit.

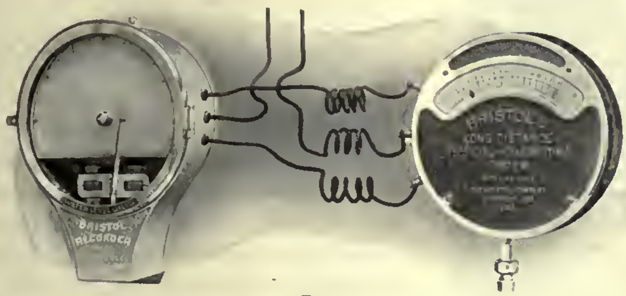


Fig. 1

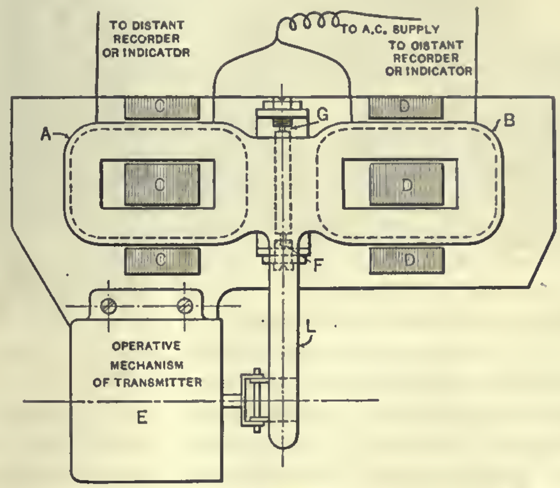


Fig. 2

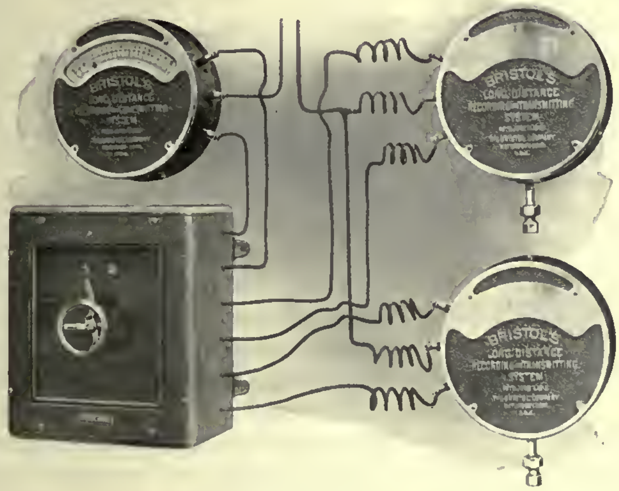


Fig. 4

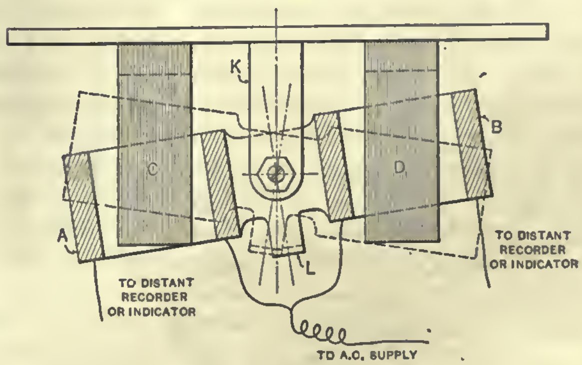


Fig. 3

In this long-distance system there are no sliding or make and break contacts, and the effects of variation of temperature or resistance along the circuit are negligible. If 110 volts and No. 14 copper wires are used, the recorder may be located 30 miles from the transmitter, or if No. 12 wires are used the recorder can be installed 40 miles or more from the transmitter.

Although this recording system is only now being put on the market it is not untried as preliminary models have been in actual service giving satisfactory results for more than 4 years.

One of the first of these instruments was installed at Peoria, Ill., to indicate at the central station the steam pressure at the end of the steam heating main, and the superintendent of the electrical department of the Central Illinois Light Co. by whom this was used has made the following statement: "In regard to this particular system which has been in service more than

4 years, two other systems were installed by us on the strength of the success by the first, and all have given very good service."

The fundamental principle of the Bristol long-distance transmitting and recording system is that of the induction balance. The complete outfit consists of two pairs of mechanically balanced solenoids arranged to swing horizontally back and forth over the ends of soft-iron cores and connected in parallel to an alternating-current circuit. One pair of the solenoids is used for the transmitting instrument, the other pair for the receiving instrument. Front view, Fig. 2, of the transmitter shows one pair of the solenoids *A* and *B* on spools connected together and supported on a shaft, the ends of which rest in jewel bearings at *G* and *F* and swing back and forth over laminated soft iron cores *C* and *D*. The top view, Fig. 3, shows the solenoids *A* and *B* of the transmitter in section and by the dotted outline the position to which the solenoids may swing is also indicated.

A similar pair of balanced solenoids is placed in the receiving recorder or indicator at the distant point. When the solenoids *A* and *B* of the transmitter and receiver are connected in parallel to an alternating-current circuit and the transmitter coils *A* and *B* are held in some certain position by the operating mechanism, *E*, Fig. 2, which may be water-level gauge, pressure gauge, thermometer, etc., the relative amounts of current flowing in solenoids *A* and *B* will depend on their relative positions to the iron cores *C* and *D* due to the inductive effect.

At the receiving instrument, the other pair of solenoids being balanced take an angular position which will be the same as that of the transmitter, since the flow of current will be the same in the corresponding solenoids of the receiver as in the transmitter. If the angular position of the solenoids at the transmitter is changed by the operating mechanism, thus moving one of the solenoids off and the other on to the iron cores, increasing the inductance in one solenoid and diminishing it in the other, the flow of current will be proportionately increased in one coil and diminished in the other. The variations of current at the distant receiver will correspond with the variations at the transmitter, and cause the pair of solenoids of the receiver to seek a position of balance which will be the same as that of the solenoids of the transmitter.

In the transmitter the operating mechanism is linked directly to the balanced solenoids by means of an arm *L*. In the receiver the recording pen or the indicating pointer is connected to a similar arm through a simple, and practically frictionless multiplying mechanism.

Various combinations of transmitting and receiving instruments of either indicating or continuous recording type may be furnished. Fig. 4 shows a combination outfit including two transmitters and one receiving indicator connected with a two-point rotary switch so that readings may be obtained with the indicator of the pressures, temperatures, etc., from either of the transmitters.

A great variety of applications for this apparatus will arise owing to its flexibility and extreme simplicity.

Fig. 5. Sirocco Fan on Special Car

A Special Car for a Sirocco Fan

Fig. 5 shows an unusual picture of a Sirocco blower fan wheel which was ordered shipped in one piece. The limit of height for a carload being 15 feet, it was necessary to procure a specially constructed flat car which would allow the wheel to project down through the floor of the car. As shown, the bottom of the wheel has been loaded to clear the top of rails by only 6 inches, thus allowing it to pass under bridges and through tunnels on the railroads. This wheel alone weighs nearly 6 tons and the sheet-steel housing for it made up another carload. The shipment was consigned to the Henderson Coal Co., at Hill Station, Pa. It is to be installed at a new coal operation of 1,000 acres, with a daily capacity of 3,000 tons of coal and employing over 500 miners. The air leaves the periphery of the fan wheel at the velocity of over 60 miles an hour, being of a velocity equal to a hurricane. There will be 150,000 cubic feet of air forced into the mine in 1 minute, which is sufficient for ten times the number of men that will be employed in the mine.

In order to realize fully what this quantity of air amounts to, this fan, running at its usual speed, could supply every hour to each of 90,000 people a chunk of air 1 foot square and 100 feet long.

An Automatic Car Coupler

"Safety first" has demanded that accidents be reduced to a minimum, and the automatic car coupler is a material aid to that end.

A mine car coupling must meet and stand up under severe conditions. It must have enough "stretch" in it to permit the cars to round short turns easily and to allow the trip to gather momentum. Yet it must be short enough to permit the bumpers to meet squarely when cars run together and to allow easy uncoupling at all times.

The coupler, shown in the accompanying Fig. 6, is composed of three parts: the coupler head, the links, and the hook. At the front of the coupler head is a trigger upon which the links rest when in position for coupling. The links are attached to the head by means of a slot and are readily detachable if necessary. When the big link is thrown from the head it falls on the hook and is locked there so that the cars cannot be uncoupled except by hand.

When cars are coupled the action of the coupler is simple. The large circular link resting on the trigger causes the lower end of the latter to project forward so that the face of the hook on the other car will strike it. This action throws the link forward onto the hook where it hangs but does not find its seat in the hook until the trip is started. Then it slides to the front part of the hook. At this point it may hang in any position, but cannot slide off, owing to the sharp increase in the width of the hook. To uncouple, the bottom part of the link is held forward and the link slid back out of the hook.

Why Anthracite Mining is Expensive

In his latest report, James E. Roderick, Chief of the Pennsylvania Department of Mines, shows that two items in mining, timbering and unwatering, are sources of no little expense. Of this phase of mining, the general public knows little, and yet the timbered gangways and drifts in the mines of the Philadelphia & Reading Coal and Iron Co. are more than 800 miles long and there is in the Schuylkill region alone a total of 2,000 miles of underground traveling ways.

Most of the timber used in the anthracite mines is yellow pine from the South, and one of the large anthracite companies, owing to the great demand and the impossibility of obtaining such timber in the North, has been sending its own cars South to expedite shipments. According to a recent calculation based on the material cost of a number of large anthracite companies, they purchase $2,593,280 worth of mine timber and lagging a year and nearly pay as much again for lumber. The operators have been using methods of preservation in some cases and are also substituting steel for wooden timbers where the work is to be permanent; concrete and masonry are also adopted to some extent.

Fig. 6

When one reflects that for every ton of coal raised to the surface there are 13½ tons of water raised, a slight idea of the influence that this has on the cost of production can be realized. It is only by increased efficiency and the introduction of mechanical labor-saving devices that anthracite operators have been able to keep the price down to its present level. The only changes in the wholesale price of anthracite since 1902 have been an advance in 1912 to offset the 10 per cent. increase in wages granted to labor that year and the increased cost of materials, and an advance of 10 cents a ton this year to meet the expense of the new Pennsylvania state tax of 2½ per cent. of the value of the coal at the mines.

Government Lignite Mine

The lignite mine of the Reclamation Service, at Williston, N. Dak., consists of a series of drifts on a 9-foot flat bed. The galleries or underground workings are at an average depth of about 100 feet below the surface.

The average output at present is 100 tons a day, and the coal is transported to the crusher near the power plant on cars hauled by mules and is there broken to nut size. The mine employs from 12 to 15 miners during the irrigation season of about 5 months in each year. The average output is 6 to 10 tons of lignite per miner daily and the net average earnings of the miners are from $3.50 to $5 a day of 8 hours. The miners are furnished with "permissible" explosives at a slight advance above cost. The mine is run in connection with an irrigation project, the fuel costing much more per ton than at regular conducted mines.

As the gas-producer and internal-combustion engines in large units come into more general use in the West, as they are rapidly doing in the East, the lignites of North Dakota will be recognized as possessing great potentialities in the settlement and economic development of the state. Experiments also show that lignite can be successfully briquetted, after which it stands transportation well and its heat value is increased 50 to 70 per cent.

Owing to the war closing the copper smelters in Utah, there has been a great decrease in the production of coal in that state. It is presumed that the anticipated cold weather will increase the present output which at present is but half normal.

TRADE NOTICES

Hoisting Machinery.—Probably the greatest record of hoisting engine production made by any one concern is that of the Lidgerwood Mfg. Co., New York, who have built more than 37,000 steam and electric hoists during the 40 odd years that they have been in business.

A comparison of the various machines built by this company today with those of 30 years ago, and still in use, is very interesting from an engineering standpoint and shows the marked advance in the way of time and labor saving improvements that has been made in hoisting machinery practice.

"*Central Station Power in Coal Mines*" is the title of a pamphlet (3078) just issued by the Westinghouse Electric and Mfg. Co. This pamphlet deals with the subject of electric power for coal mines and shows the advantages to be gained by the operator from using power from central station plants. A number of tables are given showing the cost of operation; curves are also given showing the day and night load in the mine.

Patent Decision.—The decision of the United States Circuit Court of Appeals handed down October 7, 1914, sustains the basic Conrad patent of the Hess-Bright Mfg. Co., of Philadelphia, Pa., in its action for infringement.

The suit involved only one patent, namely, that covering the article, not the one relating to a method. The uninterrupted ball track or way, however narrow such track, and the overhang of the groove sides, however slight, form the essence of the patent and are so defined by the United States Court.

The Roberts and Schaefer Co. have recently contracted to supply the following equipment: The Louisville & Nashville Railway Co. a 1,000-ton reinforced-concrete, Holmen type locomotive coaling plant, with weighing facilities, for installation at the new Radnor terminal, Nashville, Tenn. The Louisville, Henderson & St. Louis Railway Co. a 200-ton, Holmen type coaling plant with weighing facilities, at Henderson, Ky. The Illinois Central Railroad Co. for a large barge loading plant to be built immediately at Harahan Incline, New Orleans. A Marcus patent coal tipple for the Dilltown Coal Co., Dilltown, Pa.

Catalogs Wanted.—The Department of Mining Engineering, University of Kansas, Lawrence, Kans., announces that the department is revising its catalog files and getting them in shape to be of use to both students and instructors, and would be pleased to receive catalogs, descriptive matter, pictures, etc., from manufacturers and dealers in mining supplies and machinery; boilers; steam, and heat engines; hoists, drills, compressors, etc.; mine cars, mill machinery, etc. The department has a reading room and a museum for the use of students in mining, in which magazines, trade publications, etc., are kept and mining supplies displayed.

The Hyatt Roller Bearing Co., of Chicago, Detroit, and Newark, announce the resignation of Mr. John Schroeder, formerly general sales manager of that company. His successor has not yet been appointed.

American Locomotive Co., New York, announce that Mr. H. C. Hequembourg resigned as general purchasing agent, on November 15. It is not the intention to appoint a successor at present. Until further notice the purchasing and storekeeping departments will be under the jurisdiction of Mr. Leigh Best, vice-president.

Rock Island Coal Mines

The Rock Island *Employes Magazine* for November contains an interesting account of the mining department, by Carl Scholz, manager. The coal companies in which the Rock Island lines are interested are given as follows:

Rock Island Coal Mining Co., with five mines, at Hartshorne, Okla.; Coal Valley Mining Co., with one mine at Sherrard and another at Matherville, Ill.; Consolidated Indiana Coal Co., with six mines in Sullivan County, Ind., one at Melcher, Iowa, and a large area of undeveloped coal lands in Franklin County, Ill. The total areas of leased and owned coal lands aggregate 44,500 acres, containing approximately 250 million tons of unmined coal. The present output is 10,000 tons for each working day. About 2,500 men are on the coal companies pay rolls, which exceed $2,000,000 per year.

Catalogs Received

Allis-Chalmers Mfg. Co., Milwaukee, Wis., Bulletin No. 1089, Reversing Motor Planer Drive, 11 pages; Bulletin No. 1088, Distributing Transformers, 15 pages.

H. N. Elmer, 1140 Monadnock Block, Chicago, Ill., General Agent for North America and Mexico, for Siebe, Gorman & Co., Ltd. Smoke Helmets, Self-Contained Oxygen Breathing Apparatus, Resuscitating Apparatus, etc., 60 pages.

The Denver Engineering Co., Denver, Colo. Bulletin No. 1065, Electric Hoists, 4 pages; Bulletin No. 1066, Electric Hoists, 11 pages.

American Fuel Saving Co., 656 Leader-News Bldg., Cleveland, Ohio. Fuel Economy, 30 pages.

Lehigh Car, Wheel and Axle Works, Catasauqua, Pa. Catalog 50, Fuller Quality Products, 63 pages.

Metallic Packing and Mfg. Co., Elyria, Ohio. Circular, Take the Brake Off Your Pump; Martell Packings, Catalog G, 16 pages.

Thew Automatic Shovel Co., Catalog No. 9, Steam Shovels, 36 pages.

The Hill Clutch Co., Cleveland, Ohio. Catalog No. 11, Power Transmission Machinery, 224 pages.

Western Electric Co., 463 West Street, New York, N. Y. Bulletin No. 1, Cuadros Conmutadores Pequiños de Magneto. A bulletin on Western Electric Switchboards, in the Spanish language for Central and South American trade, 16 pages.

The Colliery Engineer
Formerly Mines and Minerals
XXXV—No. 6 JANUARY, 1915 Scranton, Pa.

Coal Stripping in Kansas

Mining by Open Cuts—Different Methods in Operation for Raising the Coal from the Excavations

By William Z. Price

To strip coal with shovels near the outcrop is customary in the anthracite region of Pennsylvania, but to mine the greater part of the coal in any one region by the open cut is seen only in the district in the neighborhood of Pittsburg, Kans.

Steam Shovel Delivering on High Bank

J. J. Stephenson Coal Co.'s Marion Shovel

The Cherokee seam, the only one of value in Crawford County, lies for the most part within 30 feet of the surface and at some places is but half that distance.

At most of the operations the coal is stripped by steam shovels and then mined by hand. After the cut is started, the mining is begun in a follow-up style so that when the shovel completes the first cut, it can return on a parallel one, this time depositing the overburden in the space from which the coal has been removed. There is more room for operation on the second cut and since the shovel is a revolving one, the only necessity in working back and forth is to shift the temporary track after each trip for the machine to work on in returning.

The thin layer of dirt remaining on the coal after the shovel has passed, is scraped and removed by hand in order that the coal going to the tipple may be as clean as possible. In some cases it is carried to the side where the shovel is dumping but more often to the rear of the men who are mining the coal.

At the stripping of the J. J. Stephenson Coal Co. about a mile north of Pittsburg, the operation at present consists of stripping 34 feet of cover with a Marion shovel to mine out 3 feet of coal. This is far from a paying proposition, as 25 feet is set as a safe limit for profitable recovery. The seam makes a slight depression or swamp at this point and the holes drilled in the seam for blasting are consequently more or less wet. A piece of dynamite (about one-fourth of a stick) is placed in the hole and detonated. This dries the hole sufficiently for the charge of black powder. About a quart of powder is used at each charge and approximately 110 tons of coal is loosened for each keg of the explosive consumed.

About 6 miles south of Pittsburg, the Ellsworth-Klaner Construction Co. is stripping and mining the coal for the Central Coal and Coke Co. The latter company pays a fixed price to the contractors for each ton of coal on the railroad cars, so in reality conditions are such that it is as if the contractors owned the coal and had some one else to sell it for them.

At this stripping, which will eventually be over 200 acres, are two Marion steam shovels, probably the largest in use at the present time. They each have a 90-foot boom, 54-foot arm and a 5-yard dipper. About 50 acres have been stripped since operations began 2 years ago.

The cover averages 16 to 25 feet and the seam 42 inches in thickness. All the coal is mined by hand and hauled by steam locomotives to the base of an inclined trestle, up which it is taken to the tipple. The cut is too wide to load all the coal out on a single track, so from five to eight branches are made in order to reach all the coal uncovered. Shaking screens classify the coal, that going over 2½-inch screens is lump coal, over the 1¼-inch screens is nut, and that going through is slack. About 500 tons of coal is shipped daily.

Adjacent to this operation is that of Smith, Scott & White, also contractors for the Central Coal and Coke Co. under a similar agreement. Here a new phase of transportation has been adopted. The cars after being loaded with coal are not hauled away but instead, are lifted by means of a derrick out of the pit to a track on the surface on which they are hauled by steam locomotives to the tipple. There are both advantages and disadvantages to this kind of transportation. It is advantageous in that it gives the miners freedom in moving about with no tracks to be laid and relaid while it affords a permanent track on firm even ground for the length of the entire cut. On the other hand, some contractors believe that the increased cost of a derrick makes this manner of operation unprofitable, but if an incline must be installed with engine, etc., it is doubtful if there would be any saving on that score.

Thinking that there is too much wear and tear on the cars in dropping them back on the track, another scheme has been adopted by lifting the body of the car out from its side arms while the truck remains on the rails. This method was first used by Mr. Edward Packard, of the Packard-McWilliams Co., and like the other eliminates the track in the pit and mules for gathering the cars. The crane in this case is set on the surface instead of down in the pit and moved along by its own power keeping abreast of the miners below. In this way all the coal is reached without difficulty. Six or seven 5-ton car bodies are in the pit at one time and are lifted out and returned when empty. The mining is done in a similar manner to the other stripping operations, that is, by hand. As many men are employed as can work without crowding and they are able easily to keep up with the shovel as it uncovers the coal.

Marion Steam Shovel Dipper Capacity, 5 Yards

The Old-Fashioned Team-and-Scraper Method of Stripping Coal

A serious obstruction to the mining of the coal in this region is encountered in the shape of "horsebacks." They consist of ridges of shale and fireclay, and almost give the appearance of dykes pushed up through the seam for its entire height. It is due to these horsebacks that the mining of the coal by shovels is not more generally practiced. They form less of an obstacle with the crane methods than with any other system of mining.

At few points can any evidence of dirt stains be seen in the coal, the shale overburden effectually protecting the coal from contamination by such impurity.

One pit has produced 5,600 tons for an acre of coal, but it is obvious that this will vary with the thickness of the seam.

Hoisting Car Bodies with Crane

Placing Loaded Car Bodies on Running Gear

Lifting Car with Derrick

Placing Car on Track

Ellsworth-Klaner Stripping

Horseback in Ellsworth-Klaner Stripping

Hauling Coal Out of Stephenson Stripping

Blast with Black Powder, Stephenson Stripping

The scale of wages recently adopted by the workmen and operators is so high that a fair amount of coal must be mined each day and considerable cover removed to make operation profitable. The wages are:

Steam shovel engineer	$155.00 per month
Craneman	100.00 per month
Fireman	78.00 per month
Oiler	63.00 per month
Shot foreman	3.00 for 8 hours
Tracklayer	2.70 for 8 hours
Shovelers	2.70 for 8 hours
Driver	2.62 for 8 hours
Drillers	2.50 for 8 hours
Tipple men	2.25 for 8 hours
Tipple engineer	2.84 for 8 hours

The Camera vs. the Pantograph

Photographic Methods of Making Enlarged or Reduced Copies of Maps and Engineering Records

*By H. A. Williamson**

WHILE here and there over the country the camera is found in use in engineering offices, taken as a whole very little is known of its possibilities. Originally the camera came into use in our office to reproduce, in convenient pocket size, outline maps of the workings of our mines. From this it has been extended to cover many kinds of work. At the present time, in addition to the mine maps, we copy all kinds of maps and records, make illustrations of machinery, mine interiors, exteriors, and, in fact, anything where a permanent record, graphic illustration, or working model is required, as well as pictures for all kinds of advertising. The greatest time and money saving, however, has occurred in the drafting room. For instance, a blueprint comes in which has valuable information on it, formerly the only way to make a record of this information was to have a draftsman copy it, requiring possibly several days, now a negative can be made in about 20 minutes and the blueprint returned (the photographic reproduction of a blueprint was described briefly in The Colliery Engineer, July, 1913, page 689).

In carrying out this work and adding to the usefulness of the photographic studio in connection with the engineering work, it was soon found that there was a great lack of anything written as to what other workers had accomplished along these lines, and it was continually necessary to work out every suggested use, from the ground up, in order to find out whether it was practicable or not.

In the following paragraphs an attempt has been made to show how the camera has superseded the pantograph in our drafting room. This has been written, first of all, for the man with some knowledge of photography who may wish to carry out this work, but it is hoped it will also be found of interest by all workers along this line. It has been thought necessary to go largely into detail at certain points, while at others detail has been avoided by reference to certain publications available to every one, without cost.

In the drafting office it often becomes necessary to place on one map, or drawing, information taken from several other maps, blueprints, tracings, etc., all of which may be on different scales. To accomplish such work the usual method has been to make enlargements or reductions, to a certain scale by use of the pantograph. While the high-grade pantograph is an accurate instrument, the reduction of enlargement of any extensive amount of work by its use is a slow process and therefore expensive in the amount of labor involved. The whole operation of reproducing a map or print to a larger or smaller scale can be carried out, by use of the camera, in about 5 hours.

Space Required.—It is necessary to have a photographic dark room which must be long enough to give sufficient space for making the enlargements. Ordinarily a room 10 feet long in the clear is ample, but this depends entirely on the kind of lens used and in some cases 10 feet may not be necessary. The dark room is the only permanent space required, and is, of course, available for all other photographic work. All other equipment may be set up in the drafting room from time to time and stored when not in use.

Equipment.—One standard camera with long bellows, not smaller than 8 x 10 (11 x 14 preferred).

One standard copying lens with capacity for plate one size larger than camera will take.

Three or more plate holders.

One stand for camera.

One easel.

Two photographic arc lamps.

One set dark-room equipment, trays, etc.

One enlarging attachment for camera.

One set (3) color filters.

Description of Equipment.—The camera is standard make with enlarging attachment. See foot-note No. 1.

A copying lens is a lens giving a maximum flat field, fitted with an iris diaphragm, but no shutter, a lens cap being used instead of the shutter as all exposures are comparatively long timed—there is, however, no objection to having a shutter if the lens is to be used for other work where it is necessary.

Plate holders are purchased to fit the make of camera.

Any ordinary table may be used for a stand, the only necessary features being that it be firmly put together, heavy enough not to jar easily and no casters in the feet.

The easel must be of sufficient size to take the largest map to be reproduced and also to take paper of sufficient size for the greatest enlargement to be made. Its surface must be absolutely true and it must stand in a firm base. A drafting table fitted with hinges so that it can be tilted makes a good easel.

A photographic arc lamp is a lamp giving an intense light. See foot-note No. 1. If lamps are not used it is necessary to have windows or skylights so arranged as to give ample lighting capacity.

*Consolidation Coal Co., Fairmont, W. Va. Illustrations by H. G. Cargo.

Color filters are sheets of colored material cemented between glass and are used to correct the rendering of colors such for instance as where it is desired to reproduce red and blue lines. It is only necessary to have three of these, although there are some ten or more in a complete set. See foot-note No. 2.

Numerous books are issued free by photographic companies describing ideal dark rooms and their equipment and no attempt will be made here to describe the dark room.

Method of Procedure.—Take for example a topographic map such as is issued by the United States Geological Survey and with which nearly every one is more or less familiar. The sheet includes all the topographic features, including roads, streams, and contour lines. Say you want a map of this same country but only showing roads and streams and on a scale of one-fourth mile to the inch, the original being 1 mile to the inch. With the pantograph an enlargement would have to be made on detail paper, this would probably take 3 to 4 days, depending on the character of the country and there would be the liability of errors of omission, also possible errors of scale due to slipping of bars, defects of eyesight, etc. The camera and easel are set up at a convenient place, the camera being on its stand. The requirements for this position are that if daylight is used the easel must be so placed that the light falls on its surface evenly, and the back of the camera must fall in a plane parallel with the surface of the easel, for if it does not, one side of the resulting negative will be out of scale. This parallelism of camera back and easel is the one most important point in all the work, it may be obtained by having permanent points marked by flat head nails driven flush with the floor and heads centered, these center marks being originally laid out with the utmost care; or the easel may be set up at a fixed point and the camera stand set on steel track with steel rack and pinion movement to carry it back and forward. By the first plan the nails are placed every 6 inches in the floor, in two lines (one for each front leg of the stand) vertical to the surface of the easel, then when the front legs of the stand are placed accurately on their corresponding nails (the camera being screwed down to the top of the stand so that the corners of the camera base and stand top correspond), the back of the camera will fall parallel to the easel surface. By the second method, the legs of the base are fitted with brass shoes which slide on a triangular track, which track is laid on a plane vertical to the easel surface. The rack rail is placed between the track with a worm on the bottom of the stand operated by a chain running on gears with a hand wheel conveniently placed at the back of the stand near the top. Both of these methods are shown in the accompanying illustrations, Figs. 1 and 2.

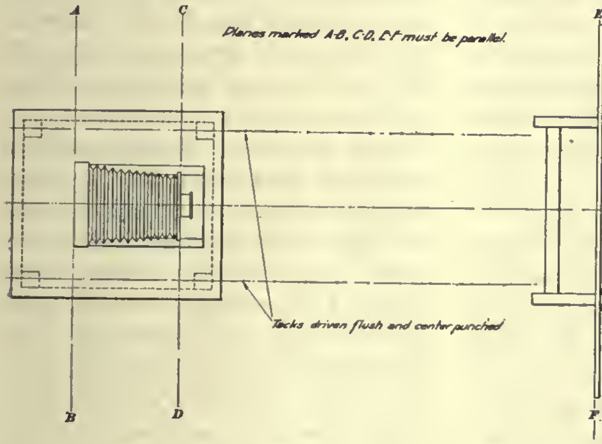


Fig. 1. Placing Camera by Tacks

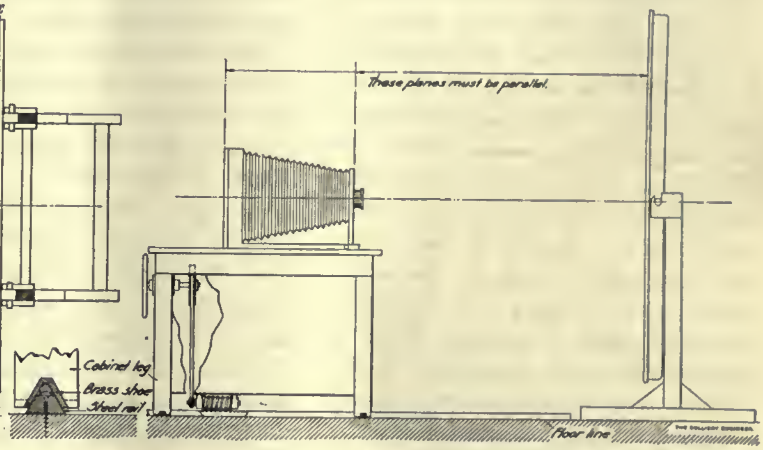


Fig. 2. Track-Operated Enlarging Apparatus

The topographic sheet is fastened on the easel by means of thumbtacks.

Focus and Scale for Glass Negative. On all maps to be photographed a scale of the character shown by Fig. 3 is placed. If the scale cannot be placed on the map permanently it is put on in heavy pencil, at a convenient point and erased later. By using this, the scale is always accurate regardless of what reduction or enlargement is made.

Fig. 3 Scale

Returning to the topographic sheet we have placed on the easel. It is noted there are several colors on the sheet, brown for contour lines, blue for streams, green for timber, and black for other information, and also a few red figures. This being the case the sheet cannot be satisfactorily photographed on the ordinary dry plate and it is necessary to use a special plate and color filter. These special plates cost very little more than the ordinary plate, the difference being that they are so made as to give a more correct value to all the different colors. One of the most satisfactory plates for reproducing topographic sheets is known as the "trichromatic" and is used in connection with a yellow or orange filter, depending on the vividness of the colors. (See foot-note No. 2.) If the object to be photographed is black and white exclusively, or

black and white with some red and orange, the special plates are not necessary and what is known as a contrast or process plate is used. The scale of our topographic sheet is 1 mile to the inch, indicated by a scale as described above. As we are to make an enlargement of this to one-fourth mile to the inch it is immaterial what the scale is on the glass negative. Assuming that an 11 x 14 plate is being used and that the color filter has been placed in position, the camera is drawn from and toward the easel until by using the focusing cloth and examining the image on the ground glass of the camera, a point is reached where the image is well within the limit of the plate and sharply in focus with the diaphragm open to its fullest extent. This being accomplished, the diaphragm is stopped down to about F16 or 32, according to the type of lens being used, the cap is placed over the lens and the light is adjusted to fall evenly over the entire surface of the topographic sheet; if arc lamps are used they are placed slightly to the rear of the front of the camera on each side of it and moved about until the illumination is even; if daylight is used it is necessary to have curtains arranged to suit local conditions—being so arranged as to control the light and make it even; if possible one should have a skylight, but it is not absolutely necessary. The exposure is then made and the plate developed in a developer that will produce sharp contrasty lines on a black ground. Such developers are usually recommended by the manufacturers on a slip which comes within each box of plates, but if not available the formulas given below will be found excellent:

Developer for Trichromatic Plates. Water, 30 ounces; sulphite soda, 2 ounces C. P. desiccated; hydrochinon or edinol, 150 grains; bromide potassium, 100 grains C. P. crystals; sodium carbonate, 2½ ounces C. P. desiccated.

Use full strength, develop 10 minutes at 70° F. Wash and fix in any good acid fixing bath.

Developer for Contrast Plates. Water, 60 ounces; sulphite soda, 9 ounces C. P. desiccated; carbonate soda, 6 ounces C. P. desiccated; hydrochinon, ½ ounce; bromide potassium, ¼ ounce C. P. crystals.

Use one part developer to one part water and add to this total ½ ounce of 10 per cent. solution bromide potassium for each 8 ounces of ready to use developer. Develop 15 minutes at 70° F. Wash and fix in any good acid fixing bath.

Both trichromatic and commercial plates should be developed in absolute darkness. Temperature of developers should never be above 70° F. or below 60° F.

In the above description of making the negative it is to be noted that the negative has been made to no particular scale, simply getting it well within the limit of the plate. If it is desired to make contact prints from this negative as well as enlargement then it is merely necessary to measure the image of the scale on the original sheet which appears on the ground glass, and move the camera until when sharply in focus this image is the proper size. That is if the scale on the original sheet is 1 mile to the inch and is represented by a line 4 inches long (4 miles), and you wish your negative to be 2 miles to the inch; measure the image and move the camera until the scale image is 2 inches long (still 4 miles) and the resulting negative will be just as correct as your eye can measure; in like manner any other scale can be obtained.

Having the Negative, to Make the Enlargement.—The enlarging camera is set up on the wall in the dark room with the light outside the dark room as per the directions given in all the enlarging books published by camera manufacturers. The easel is set up in the dark room with the same care in regard to parallelism as has already been gone over with reference to making the negative and by the same methods—in the dark room nails are to be preferred to mark the distances as the track is liable to be stumbled over when working with only the red light. The negative is placed in the enlarging camera and a large piece of clean white paper is fastened on the easel. With the room darkened, the enlarging lights on, and the cap removed from the lens, the image of the negative is thrown on the easel. Move the easel until a fairly clear image is obtained, then measure the scale image and move the easel (also making use, of course, of the focussing arrangement on the camera) until the scale image measures (in the case of our topographic sheet under discussion) exactly one-fourth mile to the inch. In other words, if the scale was originally 4 inches long it will now be 16 inches long, or such other scale as may be desired. The cap is then placed on the lens and a piece of sensitized paper substituted for the plain paper and an exposure made which will vary according to the kind of paper used. About the only satisfactory paper for this kind of work is a very rapid bromide paper known as "Insurance Bromide." It is thin, can be folded when dry, without breaking; it will also allow of writing upon it with either pen or pencil, which is very difficult with most photographic papers. This paper is developed as per instructions which come with it. For this development it is necessary to have rather large trays. A good tray is one made of zinc-coated steel that is painted with chemical-proof enamel. For enlargements to 40 inches square trays should be about 3 inches deep and 42 inches square; smaller trays can be used for smaller prints in order to economize developer. There is very little shrinkage in this paper and after a few trials, provided a good lens is used and the requirements for parallelism are observed, the operator will find it is a matter of routine to produce maps exactly to any scale desired.

The whole operation of reproducing a map to larger scale can be carried out in about 5 hours (including the drying of the final paper enlargement) if the glass negative is dried by giving it a bath in alcohol

and placing it before an electric fan. Any person who has done photographic work and who will take the trouble to ask for the free books mentioned in the foot-notes will be entirely able to carry out this work. Any professional photographer at all well equipped, could carry out this work, although it might not be done quite so accurately as in the engineering office.

Foot-note 1.—The Eastman Professional Catalog (Eastman Kodak Co., Rochester, N. Y.,) fully describes under the head of "R. O. C." View Camera and R. O. C. enlarging back, complete camera and enlarging attachment for this work. In the same book is a description of the Aristo Lamp built to work with this camera and enlarging back. The three together make an excellent combination for this work and can also be put to many other uses.

Foot-note 2.—The Eastman Kodak Co., Rochester, N. Y., and the G. Cramer Dry Plate Co., St. Louis, Mo., both put out excellent booklets on color filters, or as they are sometimes called "ray screens," and also complete descriptions and methods of use of the various orthochromatic, orthonon, trichromatic and panchromatic plates. All of these booklets are sent free on application.

The Clinkering of Coal

*By O. W. Palmenberg**

One of the most troublesome features in the combustion of coal is due to the production of clinker. This influences the rate of combustion and the cost of maintenance, especially where automatic stokers are used. A coal may clinker so readily under certain conditions that it becomes unfit for use, irrespective of its fuel value. It is, therefore, of the greatest importance to know whether a coal will clinker under the conditions for which it is required. The determination of the clinkering properties of a coal, that is, whether its ash will fuse at a low temperature, has been carried out in several ways; and many authorities have considered that an analysis of the ash, or determination of the iron in the ash, or of the sulphur in the coal, would furnish the information desired.

To show that there is no relation between the clinkering quality of a coal and the sulphur or iron content, the author has made an independent investigation of the problem. Analyses of the ash, together with the fusing temperature determinations on a wide range of coals, show that no conclusions can be drawn from a chemical analysis. It may be noted that some coals have an ash of iron-like content and variable fusion temperature; others have ash of like fusion temperature and variable iron content. It would appear, therefore, that there is no relation between the percentage of the various constituents of the ash and the fusing temperature. Hence a chemical analysis is of no value for arriving at a judgment as to the clinkering quality of a coal. The fusion temperature of the ash ought, therefore, in the future to displace the sulphur determination in coals used for steaming purposes and this change will readily show the fallacy of buying and selling coal on an analysis basis, where specifications are used containing sulphur tables penalizing beyond a certain guaranteed amount of sulphur. It has been quite a common practice to place 1.5 per cent. of sulphur as a limit, and to penalize the seller as much as 4 cents per ton for every .25 per cent. of sulphur above 1.5 per cent. The injustice of this practice is evident, as it often happens that coals with a high sulphur content are extremely high in heating value, and do not clinker readily. Since the sulphur has no appreciable effect upon the metallic parts of the furnace it need not be considered in the selection of a coal for steaming purposes. To arrive at the value of a coal for this purpose it is therefore just as essential to make the fusion test of the ash as it is to to make the calorimetric determination. If these two determinations are made, an explanation is readily found as to why two coals of apparently like proximate analyses give entirely different evaporation when fired under like conditions.

Note.—If there be merit in determining the temperature at which coal ash fuses, it would seem as if its advocates should inform the public what to do with it after it is obtained. It is well known that any ash will fuse in an electric furnace, but where are the boiler furnaces that can be regulated so as to behave and not fuse coal ash, if the constituents of the ash are in proportions to be readily fusible. From the chemical analysis of coal ash, slag calculations may be made which will give the approximate fusibility of the ash, that is, show whether the proportions of oxides are such as to slag at ordinary temperatures. This being ascertained, provisions may be made to add, if necessary, material or coal having a more refractory ash to prevent slagging. When Mr. Palmenberg states that there is no relation between the percentage of the various constituents of the ash and the fusing temperature, he flaunts the red flag of anarchy in the face of long and well established principles, which metallurgists and makers of refractory materials use daily.—Editor.

* *Mechanical Engineer*, Vol. 33, p. 194.

Hospitals in South African Mines

American miners can realize how fortunate they are when the present conditions in the Dundee district, in South Africa, are realized. If colored men are injured they have to lie on the floor of some small building and await the ambulance which often is many hours late. Then a long drive over rough roads must be undertaken.

Usually only one or two persons are injured in an accident, and they can be roughly accommodated in the room where the medicines are kept, but if a dozen men were injured in an accident, the needless suffering they would have to undergo before reaching a hospital would be terrible.

Arching in Collieries

Conditions That Have to Be Contended With Underground—The Requirements of a Durable Arch

*By Robert G. Clark, A. M. I. C. E., M. C. I., Cardiff**

UNDERGROUND arching to permanently support the roof, sides, and floor in the main roads of colliery workings has long been a problem difficult of satisfactory solution. Some arches stand well, but others get squeezed into such awkward shapes that they require con-

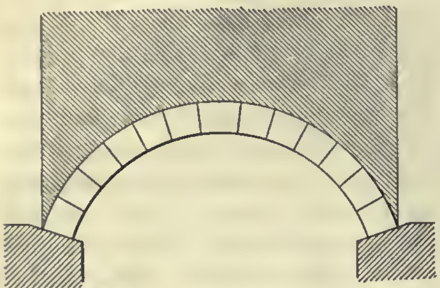


Fig. 1

stant renewal. Owing to the variations in the local conditions, the whole question resolves itself into a case of trial and error, and this uncertainty is often a continual source of expense, danger, and anxiety.

Though it must be admitted that the loads on the arching as the result of a squeeze are enormous, yet it may be of interest to endeavor to find some of the causes which contribute to their failure to support the load.

This investigation will cover the design and materials used in the construction and also the abnormal conditions that have to be contended with, and it may point to some weak parts which when remedied will add to the stability of the arches.

The arch in its varying shapes and forms can safely carry heavy loads, and compared with the beam it is more economical.

However, before an arch can be deemed suitable for any given case, there are certain fundamental conditions attached to stone, brick, or any arches made up of units with adhesive joints; and if these are unsatisfied, then the arch is unreliable.

The designer of a brick or stone arch must provide abutments capable of withstanding the oblique thrusts of the arch. Before an arch can be designed with any measure of safety, the loads both in intensity and method of application, must be determined. When arching underground there are several factors to take into account, about which no definite information is available.

For instance, the amount of the load to be supported is more or less a matter of guesswork. Further, as the sides frequently collapse, it appears that the point of application of the load is equally indefinite. Moreover, the direction of the load may be anything but normal to the arch, owing to the inclination of the strata.

From this it may be gathered that

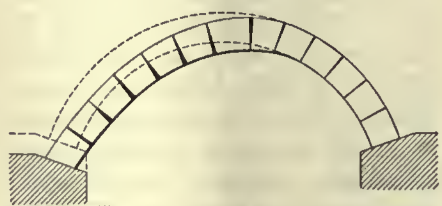


Fig. 2

the designer of arching has to face three unknown factors; namely, the intensity of the load, its point of application, and its direction.

The only information given is that so many feet of masonry or a certain thickness of brick set in cement mortar crushes under the load. As in the majority of cases the span of the arch is so short compared with its thickness, it seems incredible that the arch made of hard stone or bricks should fail by crushing pure and simple, and it is an open question whether this is actually the case.

Some of the bricks or stones may crush, but if other parts of the arch are examined, other signs, such as opening of joints or peeling, may not be wanting; and if this is found to be the case, then the primary cause is not failure by crushing, but is due to distortion.

It is obvious, however, that with three unknown factors to deal with, any refinement in calculations is impossible, and the successful solution of this problem will rely more on the comparative strengths, guided very largely by practical experience.

With this fact in view, it may be permissible to inquire how masonry and brick arches may prove unstable under varying conditions, and in Fig. 1 is shown a segmental arch constructed of block stone. The load is evenly distributed over the arch, and the skewbacks are presumed to be immovable. Under these conditions, provided the joints are well made, the load tends to add to the stability of the arch, and any failure could only take place by each stone actually crushing. All the members in the arch are in a state of compression, and represent the ideal and economic arch for materials such as stone or bricks under these conditions.

If, however, one or both of the abutments should move under the application of the load, a new condition of affairs is presented, as shown in Fig. 2 where the left-hand abutment has yielded. The arch then becomes crippled on the lines shown, and is subjected to tensile stresses on one side and compressive

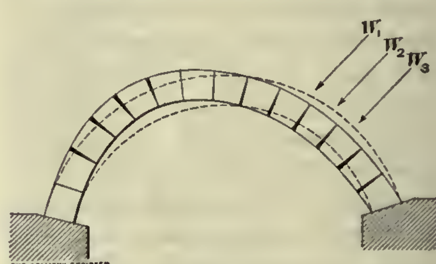


Fig. 3

stresses on the reverse, so that it acts in the nature of a beam. This is noticeable by the opening joints, and when this happens the load carrying capacity of the arch becomes

*July, 1914, Proceedings South Wales Institute of Engineers.

seriously reduced, even if the load is distributed evenly over the arch.

Going further, even if it is allowed that the abuments are immovable, yet if heavy loads are concentrated on one-half the arch, as shown in Fig. 3 at W_1, W_2, and W_3, the effect would be for these loads to cause the arch to deflect immediately under the loads, with a corresponding rise of the reverse side. In other words, the arch is distorted and tensile stresses are set up as well as compressive stresses. The effect of this distortion would be to crush some of the stones or bricks, and others again would open at the joints. In the case of brickwork with concentric rings, there may be evidence of peeling, and this, no doubt, is a contributory cause to the failures; and it is clear that although some parts of the arch show signs of crushing, it is not due so much to excessive pressure as to the effect of distortion. The safe load that can be carried on arches loaded in this manner is determined by the rise, span, and thickness of the arch.

Taking a combination of the conditions of Figs. 2 and 3; namely, yielding abutments and concentrated loads, it is apparent that any stone or brick arch that could stand would be a matter of surprise.

The result is this, that stone or brick arches are admirably fitted for such conditions as will insure the various members being in a state of compression, but any considerable tensional stresses render the arch unsuitable.

In other words, the curve of equilibrium, or neutral axis, must

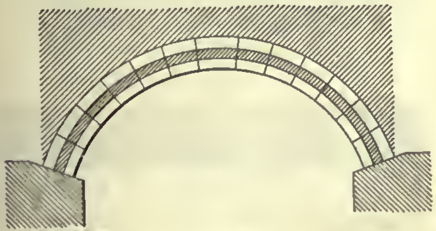


Fig. 4

fall within the middle third, as shown by the hatched portion in Fig. 4, or the arch will be unstable. It is very difficult to accurately determine where the curve of equilibrium will run in a stone or brick arch, as all depends on the perfect construction and the perfect filling of the joints. It will be realized from this that much material in a stone or brick arch is wasted.

In mine arching the loads to be supported are enormous compared with the weight of the arch; so much so that for all practical purposes the load due to the squeeze is the only load that it is necessary to consider.

Quite apart from the question of distortion, there has to be considered the thrust of the arch. In flat arches, where the ratio of span to the rise is small, the resultant thrust is nearly in a horizontal line; but as the rise increases, the line of thrust assumes a more vertical position, as shown in Fig. 6. Railway companies rarely make segmental arches with the rise H less than one-fifth of the span S, see Fig. 5. This not

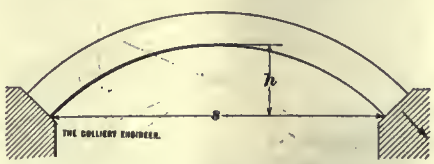


Fig. 5

only affects the cost of the arch, but in a greater degree the abutments, as the more vertical the thrust the less expensive to construct the abutment.

In masonry arches each stone should have chisel-dressed joints, so that the mortar may be as thin as possible. The joints should be normal to the arch, and the materials for the joint should be cement and sand. Great care should be exercised in making the joint and only sufficient mortar used to properly bed the adjacent stones.

This also applies to brick arches, and to a still greater extent, as there are many more joints to deal with. To use ordinary bricks and throw in a few culvert bricks at the discretion of the bricklayer, or to make fat joints here and there in order to get the bricks to the curve, is not good practice.

If the arch is constructed in rubble masonry, the result is more or less a trial and error problem; the

Fig. 6

stones being so irregular that to bed them at all large quantities of mortar are required. In some cases the proportion of mortar may reach from 10 per cent. to 30 per cent., and even then it is impossible to fill up all the voids. In most cases the mortar is coarse and a poor mixture, and what it lacks in quality it makes up in quantity; but as the crushing value of this mortar is so much less than the crushing value of the stone, it is evident that the strength of the arch is governed by the strength of the mortar. This is a very important point, as by increasing the strength of the mortar the weaker component is rendered more capable of taking higher stresses, both in compression and tension. It is evident that the question of the materials and workmanship in joint making is of the utmost importance.

In this matter of joints, concrete blocks have proved an excellent substitute for masonry or brick. It is true that the crushing value of concrete is not equal to that of stone, being about equal to the best brick; but as the joints can be made correctly and economically, there is no doubt that for equal thicknesses concrete blocks made of suitable materials would be much stronger, as joints can be made less in number.

Briefly reviewing the foregoing, it appears that masonry and brick arches should have immovable abutments, and that even then their capacity for supporting uneven loads is very limited; and last, but not least, that all joints should be made with care and with strong materials.

If it is to be assumed that the worst conditions have to be faced,

inasmuch as the squeeze may come on from any direction, it is obvious that the support must be continuous, or in other words, a closed figure.

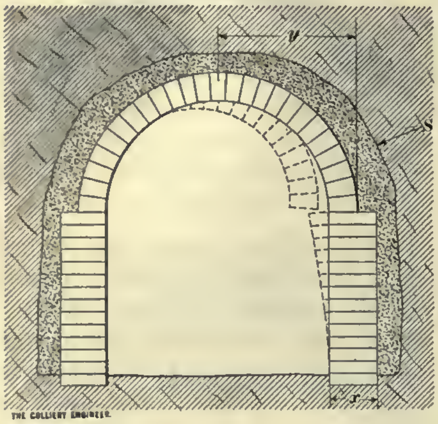


Fig. 7

A square, rectangle, or any figure having straight sides is not economical owing to the fact that it might have a tendency to rack at the joints, and as it is impossible to have any cross diagonals in the way of ties or struts, the angles would have to be made enormously strong. In this way the curves appeal to the mind, and when this is realized the circle at once commends itself, or some other curved figure such as a two-, three, or four-center arch, something after the shape shown in Fig. 8. Combinations of the curve, such as an elliptical roof and a straight invert or three parts of a circle for the upper portion and a segmental invert might possibly meet the case also.

In the case where the arching is made up of two or more segments of circles, the construction at the junctions to the right angle requires carefulness, as they act as skewbacks, and, if improperly constructed, will fail before the arch has taken its full load.

In Fig. 8 are shown properly shaped skewbacks, and it is advisable to have these shaped in one piece. More particularly does it apply when the arches are made of brickwork in concentric rings; otherwise as each ring may be imperfectly bedded, so that as the load is applied, instead of the whole arch taking the load simultaneously, each ring takes it until it fails, and the load is transferred to the next ring, and so on.

If the arch is built upon vertical walls, as in Fig. 7, and a squeeze comes on in the direction of the arrow S, it can be seen that neither the wall nor the arch can offer any substantial resistance, and deformation on the dotted lines is bound to occur. Moreover, one-half of the load on the arch y is transferred and concentrated on to the small area represented by the footing of the wall x, and this pressure may result in the roadway creeping, as it offers the least resistance.

Much depends on the footing of the wall; but it should not be overloaded, and if necessary should be widened in order to spread the

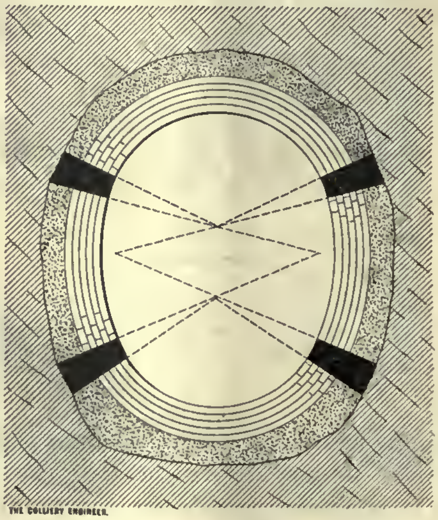


Fig. 8. Mottled Portion Represents Ashes Packing

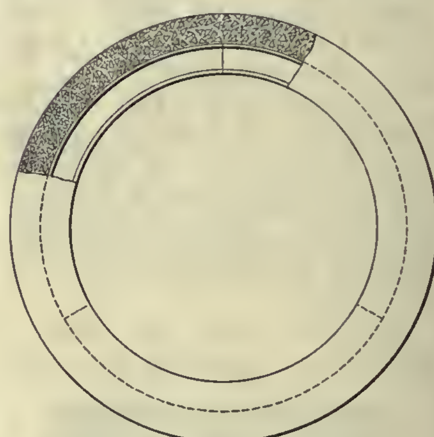
weight and reduce the pressure per square foot. To this end the vertical side walls should be designed like a retaining wall, with the base thicker than the top, the proportion to be determined by the nature of the ground.

In practical arching in mines there are two systems of construction based on opposing theories. Some hold that a wide annular space should be left between the arch and the walls of the excavation especially in the roof. After the arch has been completed, the space referred to is filled in with ashes, sand, or other soft filling material; the idea being that any squeeze would gradually compress and consolidate the ashes, thus protecting the arch from shock, and more or less converting a concentrated load into a distributed load.

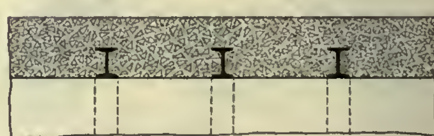
The ashes produce a cushioning effect, and although this principle may be right to a certain degree, yet it cannot be denied that by the ashes compressing it allows the abutments to move. In this way, on the application of the load, the arch flattens owing to the spreading effect of the abutments yielding. Having this in view, the suggestion has been proposed that the abutments should be made as shown in full lines, Fig. 7, and the spaces behind the arches between these abutments should be filled.

If the arching is a four-center one as shown in Fig. 8, then each abutment forms a double skewback, with each face formed and shaped to the proper angle. This is necessary, as each arch would then be capable of taking its load without any fear of the junctions giving, and at the same time it would still fall in with the principle of those who adhere to the ashes packing.

In opposition to this plan, others consider that the arch should be tightly packed to leave as little space as possible. It would be ad-



(a)



(b)

Fig. 9

visable to use concrete for this, as it would set hard and not be affected by the water.

Both of these theories evidently aim at the protection of the arch proper, and this course seems desirable when the arches are constructed of material with adhesive joints.

If the principle is accepted that the load or squeeze is the result of movement and more or less proportional thereto, then the ashes, by compressing, give latitude for the the surrounding strata to move, and any ordinary filling will also compress a little, as it is impossible to fill every little space so tightly as it was in its original state.

It appears desirable to arrest any movement quickly and it has been suggested this might be done by leaving the space back of the arching small and filling it with concrete. This would then render all solid and prevent undue distortion of the arch; in fact, the concrete filling would act as a relieving arch.

Steel beams embedded in concrete would appear to be a move in the right direction, as they need few joints, but each beam being independent of the adjoining one, does not form a lateral bond, and has to take the load without any assistance from the others, for which reason more material is required.

If the concrete arch be made in place, there is no doubt of its being

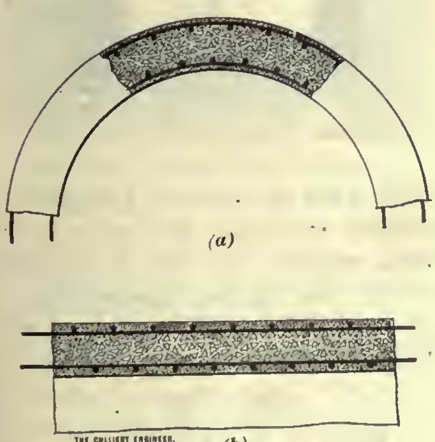


Fig. 10

stronger than either an equal thickness of brickwork or rubble masonry, as all joints would be eliminated as shown in Fig. 6. When subjected to tension the concrete would stand from 60 to 100 pounds per square inch before breaking, which is more than an adhesive joint between two bricks or blocks of stone.

As concrete is capable of standing something between 2,000 to 4,000 pounds per square inch in compression, it is obvious that only about one-sixth of its compressive strength would be developed when it would fail in tension; and to remedy this steel beams have in one instance been enveloped in the concrete 2 to 3 feet in thickness. The inside diameter of the barrel was 11 feet, and it has stood very well for a number of years [Fig. 9 (*a*) and (*b*)].

However, it will be seen that the concrete does very little duty beyond spanning between the beams. Any concentrated load would be carried by one beam only, as the concrete would fail in shear before transferring much of the load from one beam to the adjacent beams.

If, instead of using rolled steel beams, round steel bars had been used, as shown in Figs. 10 (*a*) and

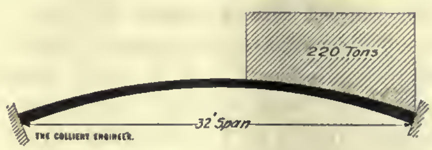


Fig. 11

(*b*), the arch would have been much stronger and more economical, as less steel and concrete would have been required.

As will be seen, by the interlacing of bars in both directions, any load is distributed and the steel is used to better advantage. The reinforcing bars would provide against both tensile and compressive stresses, and the whole arch would be without any joints; in fact, it would resemble a huge casting, and in order to demonstrate the great strength of this kind of construction, i. e., without joints, reference is here made to a ferro-concrete arch built in Austria.

The arch made some years has a clear span of 32 feet, with a rise of only 3.2 feet. The arch is 6 inches thick at the crown and 8 inches thick at the spring, and Fig. 11 represents the span and thickness to scale. This arch had a moving load over it in the shape of a locomotive weighing 53 tons, and the deflection was very small. After a locomotive test with its quick and severe reversal of stresses had been made,

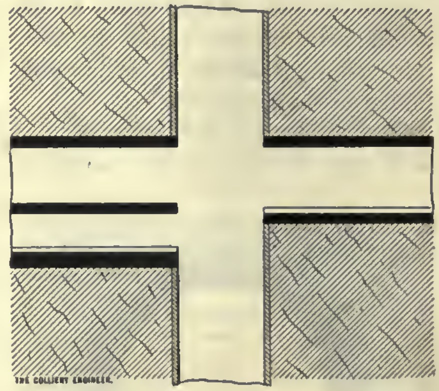


Fig. 12

one-half of span of the arch was loaded with 220 tons, as shown in Fig. 11. This represented something like 2,350 pounds per square foot. The arch then failed, because the abutments gave way. This example not only shows the great strength of ferro-concrete, but also illustrates the importance of unyielding abutments.

In Fig. 12 is shown a longitudinal section of some ferro-concrete arching constructed in a colliery in 1912.

Prior to this, brick arches had been made, and these failed from time to time, and the arches shown in Figs. 13 and 14 were put in.

The arch in Fig. 13 is 18 inches thick at the crown, and at the spring it is 3 feet 9 inches, while the invert is 2 feet 6 inches thick.

In Fig. 14 the thicknesses are about the same, but the over-all dimensions are much larger.

The partition, or collar, in the middle of Fig. 14 acted as a roof for the pump chamber 17 ft. × 7½ ft.

During construction, difficulty was experienced at first with water percolating through the clod, but the arches are now watertight and standing satisfactorily.

It is interesting to note that after the concrete in the arch had set, the irregularities and space between the outside of the arch and the roof were packed with concrete; and that no settlement or distortion was noticed prior to the setting of the concrete.

Any tendency of the arch to spread through the application of a load on the roof would be noticed at the junction of the arch with the invert, but this is prevented, as the whole is monolithic, and the steel reinforcement in the invert is continued up into the arch.

The enormous strength of this arch may be realized by comparing

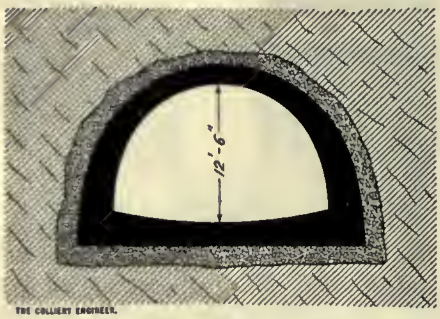


Fig. 13

the smaller span, greater rise, and increased thicknesses of the arch with that shown in Fig. 11.

The relative strengths depend largely on the amount of reinforcing steel; but, generally speaking, ferro-concrete arches of equal strength to brickwork need be about one-quarter to one-sixth the thickness. This strength is derived mainly from the absence of joints, and also from the fact that little steel is needed to reinforce the concrete in tension to make it equally strong in tension and compression.

From time to time objections have been advanced to the use of ferro-concrete underground, and although there is some ground, yet prejudice is also a factor which enters largely into the objections:

1. That the placing of a large number of small bars accurately in position and keeping them there during concreting is practically impossible underground.

2. That the squeeze may come on before the concrete has had time to set, so that the concrete would easily crush and the bars all get displaced.

3. That the squeezes are so enormous that nothing can be made to withstand them so that something is required which can easily be replaced.

4. That the centers would have to be in position for a month, during which time they would block the roadway.

5. That in wet places the cement would get washed out of the concrete, etc.

The Mine Foreman and First Aid

*By Will McIntyre, Jr.**

"There's nae luck about the house when our guid mon's away," is an old Scotch saying that implies that things go wrong when the natural leader is not on the job.

Sometimes I think that the mine foreman is not always on his job when I read the sad stories of numerous mine disasters. I do not mean to imply that the mine foreman intentionally neglects his duty, but, that he is sometimes compelled to neglect a portion of his specific work, to give time to duties that should be performed by others. The duties of a mine foreman, briefly stated, are to produce a maximum amount of coal at least cost consistent with greatest safety to human life. If he faithfully performs this duty he is necessarily a busy man, and he has no time to train first-aid corps, or to supervise their training. His time should be devoted to making, as far as possible, the work of first-aid corps unnecessary. In expressing this opinion I do not want to be misunderstood. Accidents in coal mining will happen regardless of the foreman's care, and first-aid corps are blessed institutions that alleviate suffering and often prevent death. Their organization and training should be encouraged at every coal mine, but the mine foreman should not be expected to train them or supervise their training. In the first place few mine foremen are capable of giving first-aid corps even the most elementary instruction. In some few instances foremen who, previous to becoming foremen, had first-aid instruction, may be capable of imparting their knowledge of the work, but, if they do their duty as foremen they lack the time. The best training for a first-aid corps naturally implies instruction in properly giving primary treatment to injured or otherwise incapacitated men. This instruction is imparted best by a qualified physician and surgeon. Therefore, such a man should be the teacher. The man in charge of the corps, as leader, or director should be some official other than the mine foreman. The superintendent or any intelligent subordinate, even a representative of the clerical force, if he has the qualifications of a leader, should have general charge of first-aid work. All first-aid corps must have a captain. This captain should be chosen from the actual workers on the corps, and he should be the boss when the corps is in action. But the arrangements for drills, the procuring of supplies, their custody, and numerous other details should be in the hands of a responsible man

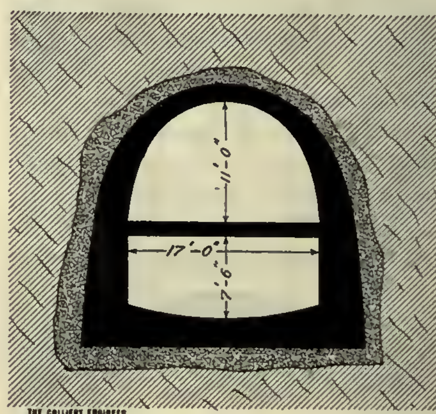


Fig. 14

who, if not an official is a regularly salaried employe. The mine foreman, whether his mine is gaseous or not, has all the responsibility a man should have, if he does his whole duty as a foreman.

* Mine Foreman, Orme, Tenn.

Illinois Coal Statistics

The following statistics of the Illinois Coal industry are for the year ending June 30, 1914:

Number of counties producing coal, 52. Number of mines and openings, 796. New mines and old mines reopened, 89. Mines closed and mines abandoned, 133.

Production, 60,715,795, a decrease of 1,130,409 tons from the previous year. Average number of days worked at all mines, 162. Number of mining machines, 1,805, an increase of 116 machines. Average number of miners employed, 32,262. Average number of other employes underground, 40,773. Total number of employed, 80,035. Number tons undercut by machines, 31,446,823. Number tons mined by hand, 29,-268,972. Number of fatal accidents per 1,000 men employed, 1.99, which is a decrease of .22.

Burning Empty Dynamite Cases

Dynamite, when spread out on the ground so as to expose as large a surface as possible, and ignited, generally burns up peacefully without exploding. The presence of metallic articles, like wire, nails (and of course blasting caps), etc., makes an explosion likely when the flame strikes it. It is essential when destroying dynamite to take it out of its wooden case on account of the presence of the nails in the latter.

The cases should be burned separately, as when they become saturated or stained with exuded nitroglycerine they almost always explode when burned, but if no dynamite is mixed up with them there is generally not enough of an explosion to do any great damage.

To set fire to them, soak a little excelsior or waste in gasoline and put one end of a piece of fuse in this, being careful to light the other end first. Have the fuse 2 or 3 feet long and the waste or excelsior under the empty dynamite cases. Or you can lay a train of excelsior and light one end with a match and run.

Dynamite cases showing any signs of being stained should never be used for fuel but should be promptly destroyed in the manner described. If they blow up in the open with everybody at a safe distance they will do no harm, but if they blow up in the kitchen stove, somebody will probably be badly hurt or killed and the house burned down. Don't take any chances.

Workable Coal Seams of Western Pennsylvania

The workable coal seams of western Pennsylvania are chiefly: First, what is known as the Pittsburg seam; second, the Upper Freeport; third, Lower Freeport; fourth, Upper Kittanning; fifth, Middle Kittanning; sixth, Lower Kittanning; seventh, Brookville; eighth, sometimes Upper Mercer; ninth, Lower Mercer; and tenth, Sharon Block.

The heights, which vary in places, are approximately as follows:

Pittsburg coal from 5 feet to 9 feet.
Upper Freeport, or coal bed E, sometimes called Lemon, from 3 feet to 4 feet.
Lower Freeport, or coal bed D, from 6 feet to 8 feet.
Upper Kittanning or coal bed C′ from 3 feet to 3 feet 6 inches.
Middle Kittanning, or coal Bed C, called also Price, from 2 feet 6 inches to 3 feet.
Lower Kittanning, or coal bed B, called also Miller, from 3 feet to 4 feet.
Clarion coal bed A′.
Brookville coal bed A, from 4 feet to 5 feet.
Mercer, Upper, from 1 foot 6 inches to 2 feet 6 inches.
Mercer, Lower, from 3 feet 6 inches to 4 feet 6 inches.
Sharon Block, from 3 feet to 4 feet.
Total, 34 feet 6 inches to 47 feet 6 inches.

The Pittsburg is adopted as a basis, because it belongs to the upper productive series, following which is the second, or lower barren measures. The Freeport, Kittanning, and Brookville seams are found in the third, or lower productive measures. In what is termed the second, or lower barren, measures there are five seams of coal ranging from none to 4 feet. These seams are not taken into consideration, owing to their lack of continuity. Yet three of them are named, the names probably being derived from the vicinity in which they crop out, and are known as Elk Lick, Baker Run, and Brush Creek coals. In the lower productive measures is also the Clarion bed.

Taking the Pittsburg as a basis, the first workable coal is the Upper Freeport, which is found at an approximate depth of from 550 to 600 feet below; 50 feet beneath, or from 600 to 650 feet, is found the Lower Freeport. About 70 feet beneath the Lower Freeport is the Upper Kittanning; 45 feet below the latter is the Middle Kittanning, and 40 feet lower we come to the Lower Kittanning. A ferriferous limestone, 15 feet thick, is found below the lower Kittanning, then comes 65 feet of shale and clay, after which is the Brookville seam.

Below the Brookville seam, about 55 feet, is the upper Mercer series. This is from 85 to 90 feet thick, composed of limestone and from 30 to 35 feet shale. It is the lowest seam before the conglomerate is reached.

The approximate depths of the workable coals beneath the Pittsburg seam, taking the latter as a basis, are as follows:

From the Pittsburg seam to Upper Freeport, 596 feet.
Upper Freeport to Lower Freeport, 55 feet.
Lower Freeport to Upper Kittanning, 70 feet.
Upper Kittanning to Middle Kittanning, 50 feet.
Middle Kittanning to Lower Kittanning, 40 feet.
Lower Kittanning to Brookville, 115 feet.
Brookville to Upper Mercer, 55 feet.
Upper Mercer to Lower Mercer, 40 feet.
Lower Mercer to Sharon Block, 130 feet.
Upper Sharon Block, 130 feet.
Total, 1,151 feet.

An approximate analysis of the various seams is as follows:

Pittsburg: Moisture 3.67, volatile matter 34.03, carbon 56.84, ash 5.46, sulphur 1.37.

Upper Freeport: Moisture 2.65, volatile matter 14.86, carbon 72.38, ash 10.11, sulphur 2.06.

Lower Freeport D: Moisture 2.86, volatile matter 22.64, carbon 67.71, ash 6.79, sulphur 1.42.

Upper Kittanning C′: Moisture 2.60, volatile matter 14.10, carbon 72.05, ash 11.25, sulphur 2.79.

Middle Kittanning: Moisture 2.7, volatile matter 20, carbon 68.5, ash 10.2, sulphur, 2.

Lower Kittanning B: Moisture 3.49, volatile matter 16.12, carbon 74.68, ash 5.71, sulphur .95.

Brookville: Moisture 2.35, volatile matter 14.3, carbon .73.12, ash 11.95, sulphur 3.30.

Upper Mercer: Moisture 1.09, volatile matter 44.08, carbon 48.25, ash 4.63, sulphur 1.95.

Lower Mercer: Moisture 2, volatile matter 42.11, carbon 44.31, ash 7.5 sulphur, 4.08.

Sharon Block: Moisture .7, volatile matter 20.4, carbon 71.3, ash 7, sulphur .6.

Bituminous Coal Storage

Storing Coal Under Water—Construction of Storage Pits—Methods of Loading and Unloading the Coal

Written for The Colliery Engineer

IN A former article the storage of bituminous coal on land was discussed from the point of view of the operators, coke makers, and railroads. For some time, however, the attention of those responsible for the control of large industrial concerns has been centered upon the problem of storing coal in large quantities so as to minimize the risk of spontaneous ignition and at the same time prevent undue deterioration. Every manufacturing enterprise that operates its own power plant is confronted with the problem of supplying fuel economically at all times; even an institution like the Metropolitan Life Insurance Co., to be on the safe side, carries a stock of anthracite varying from 5,000 to 10,000 tons. This foresightedness results from the experience gained during prolonged strikes and suspensions at coal mines; also from the inability of railroads to make quick delivery at those periods in the year when traffic is congested and there is a car shortage; besides railroads have confiscated consignments of coal when a strike was imminent or had been declared.

These conditions have existed, and not only has the cost of factory operation been materially increased thereby, but inconvenience, unnecessary expense, and even shut-downs, have resulted. In those metallurgical industries where the cost of fuel is a considerable item and the plant is dependent upon it, as in zinc smelting where about 14 tons of coal are required to smelt 1 ton of zinc, the whole margin of profit is likely to be wiped out.

It has been stated that bituminous gas coals containing 30 per cent. of volatile matter usually deteriorate more than the less volatile steam coals, and are more apt to catch fire. Professor Parr and Messrs. Porter and Ovitz made investigations to arrive at something definite concerning this difficult problem; however, judging from their conclusions there is no definite means by which it is possible to ascertain whether or not a certain bituminous coal will ignite spontaneously. However, the preponderance of evidence furnished by them points toward semibituminous and coking coals being more subject to spontaneous ignition than high volatile gas coals. It frequently happens that a pile of apparently harmless coal will heat up without the slightest warning and spontaneously ignite; in witness of this there are many piles of ashes in the anthracite fields resulting from the spontaneous combustion of culm dumps. Owing to the uncertainty of coals behaving as one would like them, cautious engineers abandoned land storage in some cases, and submerged the coal in water. Wherever this system has been adopted the additional first cost has been found to be more than balanced by the benefits gained from perfect freedom from fire and the less deterioration than in the atmosphere. H. C. Porter and F. K. Ovitz* state that semibituminous coal lost .6 per cent. in heat units in New Hampshire and 1.29 per cent. in heat units in Florida when exposed 12 months to the atmosphere. S. W. Parr and F. W. Kressman† state that Indiana and Illinois coal lost from 3 to 3½ per cent. in heat units in 12 months when exposed.

R. G. Hall‡ states that laboratory tests showed no appreciable change in heating value of Illinois coal when stored under water, but rather an appreciation, which he considers due to the removal of dust and fireclay by the water, but he adds that the slight economic increase in heat units is more than counterbalanced by the shrinkage in weight.

In 1902 the Western Electric Co., of Chicago, Ill., in order to keep on hand a supply of coal, constructed a concrete pit near the Chicago River which would hold 3,000 tons of coal. This pit was flooded and water level maintained by the Chicago River. This plan of storing coal under water was so satisfactory that when the company constructed its new plant at Hawthorne, it was decided to adopt something of a similar kind. In 1906 the concrete pit shown in Fig. 1 was commenced. It is divided into three sections, covers a ground area 114 ft. x 310 ft. and was constructed to store 10,000 tons of coal. The original plan was to make the pit 15 feet, but in some places rock was met before that depth was reached. Three railroad tracks are carried on arched concrete piers that extend the entire length of the pit, thus dividing each of the three sections of the pit into four divisions. There are also two railroad tracks on each side of the pit. A locomotive crane fitted with a grab bucket is provided to take the coal out of the storage pit and load it into coal cars that carry it to the boiler plant.

The cost of unloading has been given as 5 cents per ton and the estimated cost of reloading is 2 cents per ton. The construction cost of a pit of this description is about $7,000 per 1,000-ton capacity.

No provision has been made to dry the coal as it comes from the pit, it being considered that it is dry enough by the time it reaches the boiler furnace. To keep the pit flooded with water, rain water from the roofs of the adjoining buildings is piped to it, and when this is not sufficient water from the city mains is turned in.

In the Hawthorne, Ill., pit 1-inch screenings are stored, and naturally being very wet it is allowed to stand from 24 to 48 hours to allow the water to drain after it has been lifted from the pit.

When it is necessary to draw on the renewed supply in the pit, the

*U. S. Bureau Mines Technical Paper No. 16.
†Bulletin 38, University of Illinois.
‡*Mining and Scientific Press*, March 15, 1913.

cars are placed on the two outside tracks and a locomotive crane operating between them loads them with coal by means of a grab bucket. After the coal has drained, the cars are switched over to the power plant and run on a trestle to the bunkers over the boilers. The coal is fed by chutes from the bunkers to the mechanical stokers.

With all the advantages the storage of coal under water possesses, there are a certain number of undesirable factors, the most serious one being that of expense. A contingency which must not be overlooked is the possibility of the storage pile freezing to a considerable depth, but so far as could be learned this feature had not been troublesome in the Chicago climate where there are two plants of this kind, or at Omaha, where there is a 6,000-ton plant. At Omaha the tanks are 22 feet deep, and the concrete side walls are carried on piles owing to a stratum of quicksand. Piles at a pitch were also driven under the whole floor area and capped with slabs of concrete upon which the floor rests. In this way the load is brought on the piles and none of it is upon the earth. The side walls are about 2 feet thick at the top and 4 feet 6 inches at the bottom, and the concrete floor is protected from the bite of the grab bucket by means of imbedded rails.

Mr. R. G. Hall cites an instance where an abandoned clay pit was utilized for the storage of 100,000 tons of coal screenings, at a zinc plant using Illinois coal at the rate of several hundred tons daily. The pit was irregularly elliptical in shape about 450 feet long and 250 feet broad, while the depth was 45 feet. On account of drainage conditions this pit was always filled with water to within 5 feet of the top. Its banks below this 5 feet of surface loam were quite steep and with the floor were of comparatively hard shale, thus making an ideal reservoir.

Owing to the small margin allowable, it was absolutely necessary that the labor and power costs should be low. Experiments showed that the coal could be handled entirely by water through centrifugal pumps, but it was some time before the proper kind of pump was secured to pump coal with a minimum of water. The pump is not necessarily the most economical of power for excavating material, but during the pumping of 50,000 tons of coal it maintained an average of at least 30 per cent. solids and only choked once.

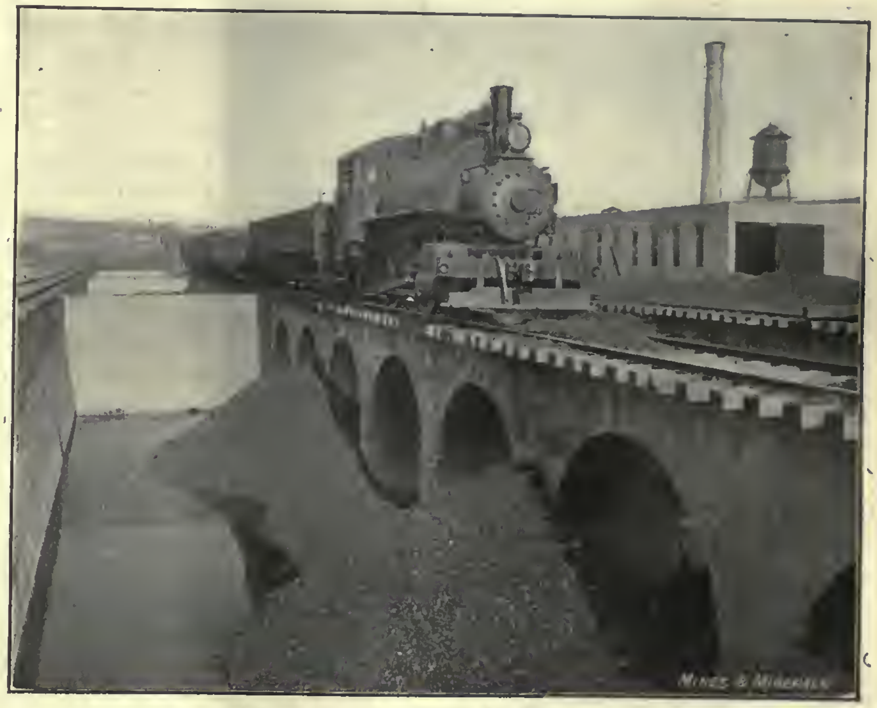


Fig. 1. Coal Pit of Western Electric Co.

The railroad track that parallels the longest side of the pit has space for 30 cars. Where the railroad comes close to the side of the pond, the track is carried on a low trestle over an unloading chute, sufficiently wide to accommodate one coal car, and only so much below the trestle as to allow about 1 foot clearance under the track stringers. The bottom of the chute has a 10-per-cent. slope toward the pond, while the outlet into the pond is constricted to about 4 feet wide. At the high end of the chute is a 10-inch pipe having six 4-inch holes in the side. This pipe is attached to a 10-inch centrifugal pump delivering about 3,500 gallons per minute. The tailpipe to this pump is back in the pond, properly protected from an influx of coal. The cars used drop their loads in four sections, two on each side.

When the loaded car is placed on the trestle two men open the drops, section by section, which takes about 2 minutes. This throws about 90 per cent. of the coal into the chute, and causes the water to back up in the chute until the accumulation is sufficient to move the whole mass of material. On account of the narrow mouth to the chute, the velocity attained is at times sufficient to carry the greater portion of the material at least half way out into the pond. When the bulk of the material has moved out, the men close a valve in the pipe to the chute, and this throws the whole stream of water directly into the car. A few moments of the stream properly directed into the sides and ends is sufficient to clear the car. The whole operation, from the time one car is ready to unload until the next is ready, averages 10 minutes. The actual operation requires much less, but delays are frequent, owing to "bad-order" drops on the cars. The actual unloading capacity of the plant is limited by the trackage and the ability to get the cars switched

often enough. Owing to the limitations of space, only about 15 cars can be handled without reswitching. As it is possible to get service twice daily, there is no difficulty in unloading 30 cars, or 1,500 tons, in a day. This is done at a labor cost of $4 and a power cost of from $10 to $20. When the coal around the mouth of the chute accumulates so that its removal becomes necessary, it is thrown out to the remoter parts of the pond by means of the coal pump. These two pumps are operated by electric motors, supplied with current from the local utility company. As the power demand is intermittent, the price charged for the actual consumption is high, averaging about 5 cents per kilowatt hour.

Fig. 2 Discharge Pipe on Pontoons

Adjacent to the unloading chute is the reloading machinery. The part on the bank consists simply of a hopper-shaped hole excavated in the ground and lined with plank. In the hopper is placed the boot of the reloading elevator; the sides of the hopper slope directly into the elevator. The arrangement is such that the coal and water are pumped directly into the elevator boot, and the water is forced to travel slowly around the hopper before finding its way back into the pond. The elevator consists of long-pitch steel chain, provided with continuous buckets especially designed for this work. At the present speed, it has a capacity of 5 tons per minute, but will admit of a large increase over this capacity.

The coal pump is placed on a barge 15 ft. x 40 ft., and is belted to a 50-horsepower motor, which has been found to be unnecessarily large. Both the suction and discharge are light spiral riveted iron pipes, and the short life of this material will be more than compensated by the ease of its manipulation. The discharge pipe is carried on pontoons as shown in Fig. 2 made from common oil barrels. One operator on the barge finds no difficulty in moving around as the ground is worked out. For the most part, when the pump is drawing from the bottom of the pond and in a good stock of coal, the material will be drawn from a long distance, so that as much as 50 cars of coal will be loaded without a new setting of the barge. As the stock gets low, more frequent moves become necessary.

Contrary to expectations, an elaborate settling system was unnecessary, as the hopper proved ample for the purpose.

Tests showed no appreciable depreciation in the heating value from freshly mined coal.

This storage project was undertaken as an insurance measure, to guard against strikes, and to provide some means of equalizing the prices of coal at different seasons in the local Illinois field. As such it has been an unqualified success. The cost of the equipment of such a pit of approximately 80,000 to 100,000 tons is about $10,000, exclusive of the pit itself.

The cost of Illinois screenings during the time they are most plentiful averages about 55 cents per ton, and the experience is that the shrinkage of total tonnage during the two operations of switching in, unloading, reloading, and switching out again will be about 10 per cent. The switching or stoppage charge in this case is $3 per car. Taking into account all charges against the coal, the final costs may be stated as follows:

	Per Ton
Cost of coal	$.550
Interest and amortization on plant	.020
Labor cost	.015
Power cost	.035
Supplies, maintenance, and insurance	.015
Interest on cost of coal	.025
Depreciation of coal	.055
Switching or stoppage charge	.060
Total cost of coal	$.775

This takes no account of watchman's services, which under proper conditions would not be necessary, and also assumes that the coal remains in the pit only during one season.

It is to be noted that this method of handling is based entirely on the use of screenings. Experiments have shown, however, that with properly designed apparatus and machines, equally as good results may be obtained in the handling of material not coarser than 6-inch screen. Where it is necessary to use cars with tight bottoms, there has been worked out another method of unloading which costs no more for labor and power than above given, and has the advantage over dumping with cradle that the first cost and complications of plant are much less.

By adopting the wet storage method the capacity per unit area of ground covered can be increased over land storage piles. If 20 feet is the maximum height of the land storage pile, the storage capacity is limited to 30 or 40 tons to every 90 square feet and thus an acre of ground space will accommodate 18,000 tons, approximately. With all the advantages offered by the storage of coal under water, there are a number of undesirable factors, the most prominent being the expense connected with building the reservoirs and lining them with concrete.

At present the cost of stocking coal is considered to be no more than the value of the land on which the coal stands, although to this must be added constant supervision and working out suspicious parts of the heap.

In this connection a land and water storage might be of great value to the coal man; that is, the coal could be stored on land and in case it took fire it could be raised and immediately placed in the wet storage before there was much damage done. In this case the wet storage pit need not be extremely large and need not contain coal except that loaded in from the pile lining the banks of the reservoir.

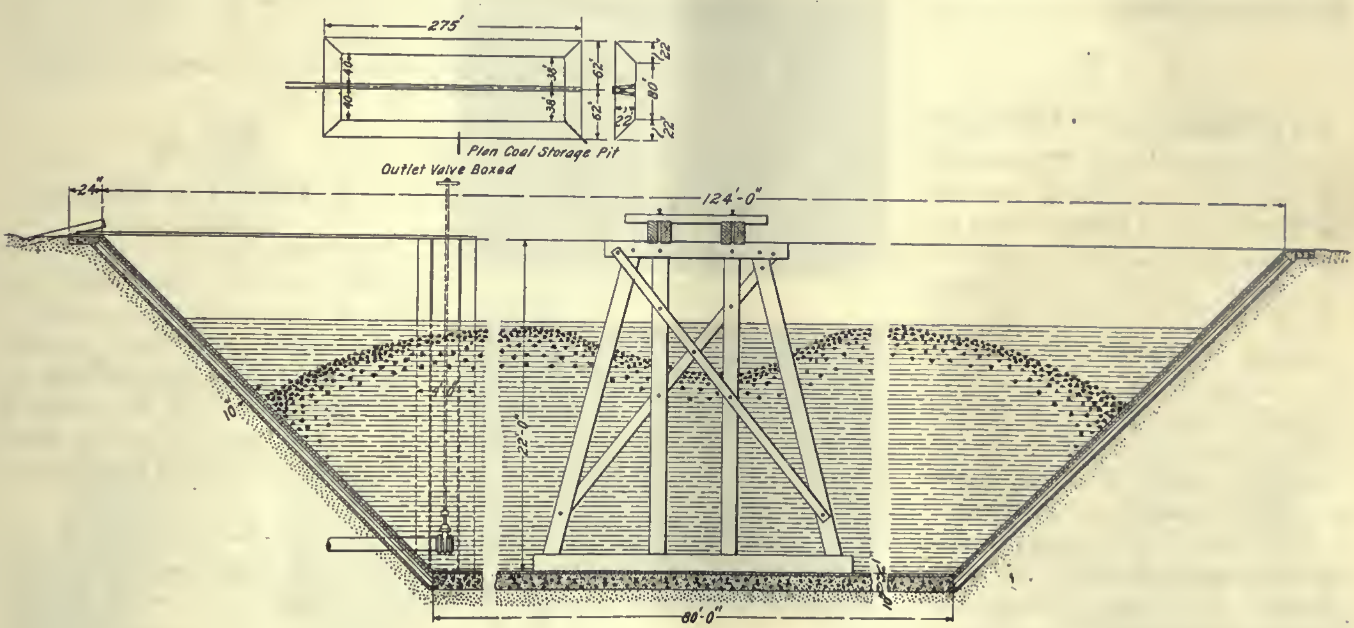


FIG. 3. COAL STORAGE PIT, MACKINAW, ILL.

Wet storage reservoirs constructed of reinforced concrete must be designed with retaining walls, and in some instances require concrete floors, but much, as has been shown, will depend on the site of the reservoir. Again, wet storage plants may require pumping machinery for emptying and filling purposes, but here again conditions may be favorable, as shown, and no filling required; or a pump may be used to remove the coal from the pit, and the water may run in as fast as removed.

One of the largest reservoirs for the storage of coal under water is, according to the *London Times*, at Stettin, where two tanks were built on the banks of the river Oder, designed for a capacity of 20,000 tons. When coal has been subjected to storage under water for a long time it is said to be somewhat brittle and dull in appearance. The latter effect is merely superficial and in drying in the sun soon disappears. In many cases, however, time would not permit of the coal being set aside for drying, and the consumer would be faced with the difficulty of using fuel containing a high percentage of water. For steam raising and all firing purposes this would no doubt be of little account, but the question cannot be considered lightly when the coal is destined for gas-making purposes.

Large electric roads like the Illinois Traction system with its 425 miles of roadbed and 1,043 cars must keep a 60-day supply of coal on hand for the various power stations. To insure a sufficient supply this company has constructed at Mackinaw, Ill., a storage pit having a capacity of 16,000 tons, and one at Riverton, Ill., having a capacity of 9,000 tons. The Mackinaw pit is shown in section, Fig. 3. Its floor length is 275 feet; its length over all on the surface is 319 feet; its width on the floor is 80 feet, and at the top over all 128 feet. The water for this storage pit is pumped from the river by motor-driven contrifugal pumps. In case it is necessary to change the water a 10-inch valve is opened which allows the water to escape into the river. The yellow pine wooden trestle 24 feet high which extends the length of the pit, rests on concrete reenforced with steel rails, and the floor between the trestle and the sides of the pit is also reenforced with rails 4 feet apart.

The Riverton storage pit is 20 feet deep, 124 feet at the top, 80 feet wide on the floor, 225 feet long at the top, and 185 feet long at the bottom. It has a capacity of 9,000 tons of coal and is constructed without the rail reenforced concrete, triangular mesh of American Steel and Wire Co. being substituted.

Under the concrete floor there are concrete foundations for the bents to stand upon, and the concrete is surfaced with a 1-inch wearing surface containing a 2-per-cent. waterproofing compound. In this case the outlet valve is 14 inches in diameter and the water is pumped to the pit from the power station at the river. No data as to the cost of loading and unloading were obtainable from J. M. Bosenbury, Superintendent of Motive Power, because he did not have it at the time this was written, but he furnished the cost of constructing the pits as follows:

The Mackinaw pit was located on ground which had the natural ad-

vantage of not requiring the maximum amount of excavation. It cost, all told, about $14,300, which makes $900 per 1,000 tons capacity.

The Riverton pit cost $11,000, all told, and being advantageously situated it was only necessary to build the earth embankments to hold the concrete retaining side walls of the pit. In this case the cost was about $1,225 per 1,000 tons.

The Humidity of Mine Air

An investigation of the humidity of mine air with especial reference to the coal mines in Illinois has just been completed under a cooperative agreement between the United States Bureau of Mines, the Department of Mining Engineering of the University of Illinois, and the Illinois Geological Survey. The results of this investigation are contained in Bulletin 83 of the Bureau of Mines, written by R. Y. Williams.

Particular attention was given to the occurrence of gas in the southern part of the state, to the inflammability of coal dust of many mines, to the control of ventilating currents, and to the factors affecting the humidity of mine air, with reference to their bearing on mine explosions.

Experiments in the gas-and-dust gallery at the Pittsburg testing station verified the fact that certain dusts that explode violently when dry are rendered inert by proper humidification of the atmosphere within the gallery, and the importance of humidity as a factor in limiting the inflammability of coal dust in a mine is demonstrated by the fact that there has never been in Illinois a dust explosion during the summer months, whereas the records show a number of dust explosions during the cold weather. The warm moisture-laden air that enters a mine in the summer deposits moisture on cooling, whereas the cold and relatively dry air that enters in winter must take up moisture as it becomes heated in traveling through the mine.

A study of humidity in the coal mines of the state was begun in January, 1912, by the Illinois Coal Mining Investigations, in cooperation with the United States Weather Bureau and the operators of twenty typical mines in the state. In this study records were made that show the humidity changes both under-

Mine Car Dump

ground and on the surface during the seasonal changes of a complete year. These records afford a basis for generalizations as to humidity, and, with pertinent discussion, are presented in the report for the purpose of supplying information that will assist operators and miners in making mines safe from coal-dust explosions.

The following general conclusions are reached by the author: The fact that dry bituminous-coal dust will explode under certain conditions has been proved both by the experience of the past and by laboratory tests.

That coal dust may be rendered inert by the proper application of moisture has been shown by the laboratory tests and by the absence of explosions at mines in which moisture is present in the proper proportion to the quantity of dust produced.

The result of the investigations of the humidity of mine air leads to the belief that steam supplied to the intake air offers the most economical and efficient method of dampening coal dust.

A Mine Car Dump

By Frank C. Perkins

The operation of a car dump utilized by the Consolidated Fuel Co., at Hiawatha, Utah, shows a greater capacity per hour than former designs and there has been less than $25 spent on it for repairs in the past 18 months, during which time it has handled 300,000 tons of coal.

The dump does not rack or damage the mine cars, which are easily kept in shape due to the fact that they are of solid construction without end doors or any loose parts and that the wheels are loose and free while the car is in a dumped position. There are no loose axles or axle boxes, the top of the tipple is never littered with coal because the car deposits all the coal in the bin, thus the dump is never choked or delayed in its operation due to accumulated coal around the tracks and brake levers.

Ductile Tungsten

The American Academy of Arts and Sciences has awarded the Rumford Medal to Dr. William D. Coolidge for the discovery of "ductile tungsten." The *General Electric Review* considers that this discovery saves the public somewhere near $1,000,000 daily in incandescent lamps alone. Also that in a number of instances it supplants platinum, owing to its higher melting point, lower vapor pressure, and greater conductivity.

Sinking by the Drop-Shaft Method

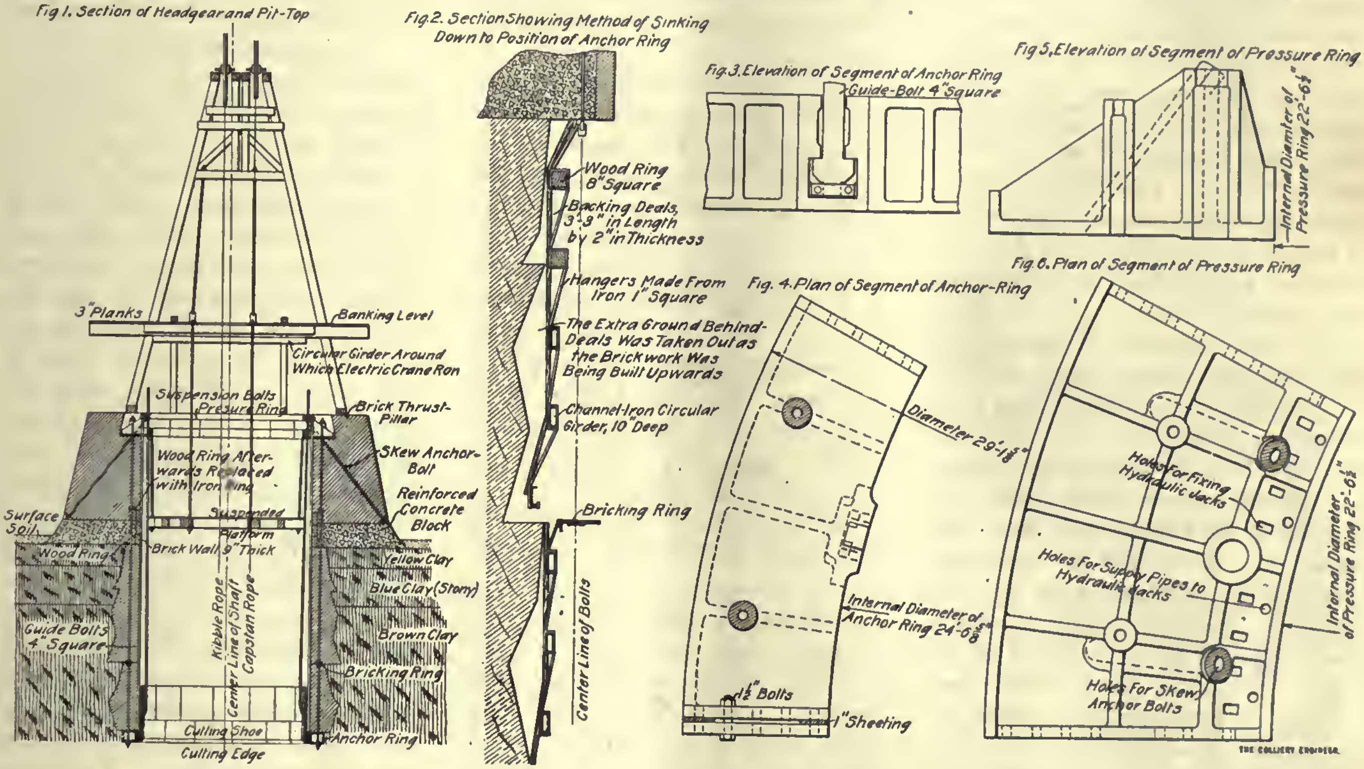
The Sinking of the Astley Green Shaft, at Astley, Near Manchester, by Means of the Drop-Shaft Method and Underhanging Tubbing

By Charles Pilkington and Percy Lee Wood

THE Pilkington Colliery is near Manchester, England, and is owned by the Clifton & Kersley Coal Co., Ltd. This property contains about 700 Cheshire acres, or about 1,481 statute acres, and extends from the Astley & Tyldesley Co.'s property to the south beyond the Manchester & Liverpool Railway on Chat Moss. The coal measures, which dip about 11⅓ degrees to the south, comprise the complete series from the Worsley mine Four-feet bed down to the Arley mine bed. The cover above the coal is drift, marls, and sandstones; the latter carrying water, it was necessary to sink at the highest point on the property in order to tub back the water.

In the year 1899, a bore hole was put down to the depth of the shafts now sunk. To this day a large volume of water gushes up freely from the mouth of the bore hole.

In 1907, a hole, 24 inches in diameter, was drilled 30 feet from the center of the present No. 1 shaft in the hope that it might be used for draining the shaft, but it subsequently proved only a source of expense, anxiety, and delay.



FIGS. 1 TO 6. DETAILS OF SINKING OF ASTLEY GREEN SHAFT

This boring proved the drifts to be 99 feet 4 inches thick, and the marls and sandstone 310 feet 7 inches thick, and freely watered.

Fortunately, the first 30 feet from the surface consisted of strong clay, but practically the remainder of the 69 feet of drift consisted of layers and pockets of sand, gravel, and marl, with glacial boulders.

A considerable amount of thought was given as to the best means of sinking. The Kind-Chaudron system being, of course, out of the question in loose ground, the only other feasible schemes of getting through this drift that presented themselves were the freezing process and the drop-shaft system. It was decided to adopt the latter, which has proved successful.

It is important with the drop-shaft system to have an adequate weight of masonry at the surface to provide resistance to the enormous hydraulic pressure which it is necessary to use in order to push the tubbing down. The arrangement for securing this resistance is shown in Fig. 1. A wooden ring was first laid on the surface clay, the center of this ring being the center of the shaft. In this ring 26 equidistant holes were bored at a radius of 13 feet 9 inches from the center, and upon it a circular ring of 9-inch brickwork, with an inside radius of 12 feet 5½ inches, was built 5 feet high to the same center. On the top of this brickwork another wooden ring similar to the first one was fastened, with the holes in the two rings exactly plumb. Bolts, 1½ inches in diameter, 6 feet ⅝ inch long, and threaded at each end, were then placed in the holes and pushed 9 inches into the clay. A

large octagonal and very strongly reinforced-concrete block, measuring about 50 feet across, was then built around the outside of this brickwork.

As the concrete was built up, it enclosed and fastened short bolts which were temporarily held in position by the two wooden rings. The concrete being only 3½ feet deep, another short wall was built around the outside of the 5 feet of brickwork, enclosing the bolts in solid masonry, after which the top wooden ring was removed, and a cast-iron ring, having holes through which the ends of the vertical bolts protruded, was substituted. These bolts were threaded at each end for 3 inches to take sleeve nuts 5 inches long to enable them to be lengthened later.

The sinking was commenced in the ordinary way, with skeleton rings and lagging as shown in Fig. 2. When a depth of 17 feet was reached, a bricking ring was placed around the bottom of the shaft, supported by 26 bolts, which were fastened by turnbuckles to the short rods which had been built into the concrete, the lower ends of which were exposed by the removal of the clay. Bricking was then commenced, the lagging being taken out as the brickwork was put in, and the outer side of the bricking made as zigzag as possible, so as to give the clay a good hold. The sinking was then continued as before to the bottom of the clay. The main anchor ring, shown in Figs. 3 and 4, was then laid on the bottom of the shaft and supported by the 26 bolts extended by turnbuckles. It was very carefully fixed to the true center, and the brickwork above it finished.

To keep the surface clay as solid as possible during the sinking, it was considered inadvisable to erect the head-gear or extend the thrust pillar to its final height until the anchor ring was in place. The sinking therefore down to that depth had been carried out by a long gib crane, which was found to be very satisfactory, and useful also for building the head-gear and afterwards for bringing the tubbing plates to the upper deck.

The next operation was building the brick thrust pillar, on which the large pressure ring was to rest. It will be noticed in Fig. 1 that anchor bolts are placed at an angle between the pressure ring and the outside of the pillar.

When the brickwork had reached the desired height, the pressure rings, Figs. 5 and 6, was laid in position.

Each segment of the pressure ring was fixed in the correct position, plumb with the recesses in the anchor ring, 44 feet below, until the whole circle was formed. Bolts were then loosely inserted, and pure cement was poured between the joints of the castings. When the cement had set, the bolts were tightly screwed up, making the ring one solid mass. The skew holding down bolts were then placed in position, and the remaining portion of the brick pillar completed.

The next process was to put long mild steel anchor rods, 4 inches square, between the pressure ring and the anchor ring. The top ends of these rods were forged circular, 5¾ inches in diameter, and threaded. On to the bottom ends, which were to go into the anchor ring, were forged two shoulders, shown in Figs. 7, 8, and 9. The rod joint was designed so that there should be no projection toward the inside of the shaft.

To screw the nuts at the top of the pressure ring tight, and make the pressure ring with its pillar and anchor ring with the shaft brickwork solid, a huge key worked by a winch through the medium of pulley blocks was used. The anchor rods served a double purpose: they acted as guides for pushing down the tubbing, their inside diameter being only 1½ inches larger than the outside of the tubbing; and they took the full pressure exerted by the hydraulic jacks placed under the pressure ring, which often amounted to over 1,800 tons, and transmitted it to the anchor ring, which owed its power of resisting the strain to the solid mass of masonry weighing something like 1,200 tons, and to the way in which the brickwork below the surface level had been built into the clay.

On the completion of this work, the sinking head-gear and banking platform were erected, and with the sinking engines in position the cutting shoe was placed at the bottom of the shaft.

This cutting shoe was of cast steel and to give extra strength to the joints, boiler plates were inserted in a recess provided for the purpose at the back of the ring, the joints of the boiler plates coming in the center of each segment of the cutting shoe. The boiler plates were held to the main castings by setscrews. In order to clear a way for the tubbing as it was forced down, the cutting edge of the shoe was made ¾ inch larger in diameter than the upper part. After the shoe segments were bolted into a solid ring, the first ring of cast-iron tubbing was bolted on top of it. In order to insure that the tubbing would keep absolutely plumb, twelve suspension bolts, 1½ inches in diameter, were let down the side of the shaft from the pressure ring to the holes in the horizontal joints between the first ring of tubbing and the cutting shoe, as shown in Fig. 1. Each long bolt was provided at the top end with a thread 6 feet long. The lengths of the bolts were so arranged that when they tightened and held the weight of the ring and the cutting shoe, 5¾ feet of their length was protruding above the pressure ring, the 3 inches below the nut being provided to allow for lifting the cutting shoe and the first ring of tubbing from the bottom of the shaft. This lifting permitted the withdrawal of the boards on which the shoe rested, and kept the cutting shoe and the first ring of tubbing absolutely level.

A second ring of tubbing was then put on. It will be seen that had the building continued, the weight of the tubbing suspended on the bolts would have been sufficiently great

to break them; therefore, as each tubbing ring was placed in position, the nuts on the suspending bolts were slackened at exactly the same time to allow the cutting shoe to sink evenly into the ground, and in this way take the greater portion of the weight. It was necessary, however, to be most careful always to keep sufficient strain on the bolts to prevent one part of the cutting shoe from going further into the ground than the other, owing to the soft nature of the strata on one side.

By the time the tubbing was built to the required distance, immediately underneath the pressure ring, the cutting shoe had sunk into the ground about 5 feet. The tubbing plates having then the full length of the shaft to act as a guide and prevent them from getting out of the perpendicular, the long suspension bolts were no longer necessary.

All the tubbing plates used in the drop-shaft portion of the sinking were 3 inches thick, with flanges of the same thickness, thirteen plates making one ring.

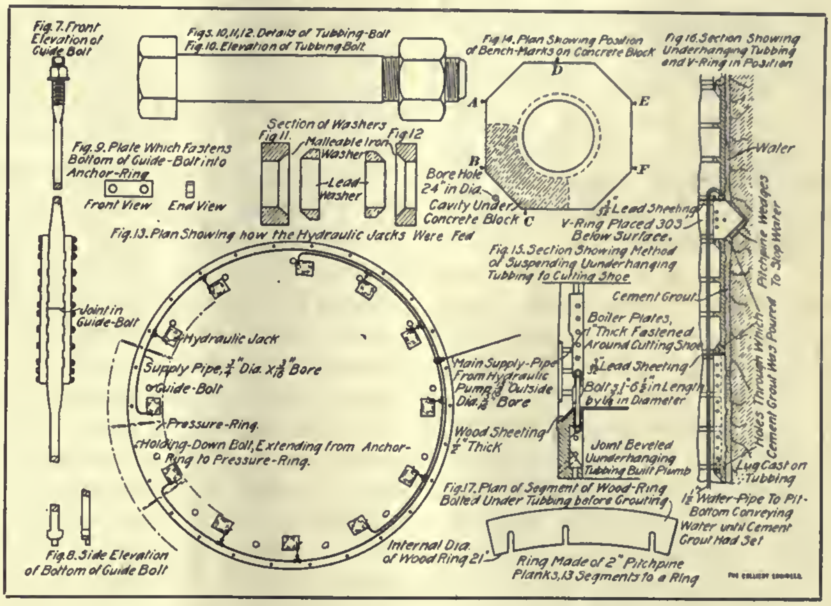
In order to give extra rigidity to the cutting shoe, the holes in the first four rings of tubbing were drilled out to the exact size of the bolts, 1⅜ inches in diameter; the other tubbing throughout the shaft had holes slightly larger than the diameter of the bolts, so that any irregularities in the tubbing did not prevent the bolts from being easily inserted. A special feature of these bolts was the beveled malleable-iron washer put at each end of the bolt together with the lead washer, (Figs. 10, 11, and 12,) to prevent water from leaking through the bolt holes. Between the horizontal and vertical joints of the tubbing, sheet lead ³⁄₃₂-inch thick was inserted, the holes being punched out *in situ* to insure an absolute fit. The lead was allowed to protrude ¼ inch on the inside of the shaft, for calking purposes.

After the tubbing was within 6 feet of the pressure ring, twelve hydraulic jacks were placed underneath the pressure ring, and suspended by strong bolts through holes provided in the casting. The hydraulic jacks could each exert a working pressure of over 150 tons, and were fed by a steam pump, the maximum water pressure being 5 tons to the square inch. A shoe was placed on the bottom of the piston of each jack, which adapted itself exactly to the tubbing. Fig. 13 shows how the jacks were fed. A special feature of the jacks was that, by opening one tap and closing another, the water pressure would lift the pistons to the top of the stroke, which saved a great deal of labor, as the pistons were very heavy. The tubbing rings were each 4 feet 11¹⁄₁₆ inches in height; the hydraulic jacks, however, only had a stroke of 22 inches, as they would have been much too cumbersome with a 5-foot stroke, therefore, two cast-iron rings were made, each being one-third of the height of the standard rings. When the jacks had pressed a new ring of tubbing down 22 inches, the pistons were raised to the normal position, and one of the small rings of tubbing was temporarily bolted on to the last main ring of tubbing. This in its turn was pushed down, after which the second small ring of tubbing was inserted and pushed down. After the pistons were raised, the two temporary rings were taken off, and a permanent ring of tubbing placed in position. This process was repeated, until the whole of the tubbing was pushed down to a total depth of 112¾ feet.

To expedite handling the rings at the surface, a circular track, 22 feet in diameter, formed of H girders, was slung from the main banking deck, and on this an electric crane moved, having one motor to do the traveling work and another for the lifting.

The large tubbing plates were brought to the site in railway wagons, lifted out by the gib crane, placed on the top banking deck, and slewed until they were right against the bucket rope. To this rope were fastened two special chains with attachments for fitting them through two of the bolt holes in the tubbing plates.

When these attachments were placed in position and the bucket rope tightened, the crane chains became slack and were unhooked; the segment was then lowered to just above the permanent scaffold, when the electric crane chains were hooked into the tubbing plate, and the crane then ran the plate, round to the position in which it had to be fixed. Each tubbing plate weighed 2 tons, but with this arrangement they were moved about with the greatest ease and dispatch.



Figs. 7 to 18. Details of Sinking of Astley Green Shaft

The hydraulic pressure required to push the tubbing down varied according to the strata that were being pushed through, but it was the practice to push the tubbing into the shaft bottom so far as it would go to lessen the rush of water and sand under the cutting edge of the shoe.

The pressure was often kept on the jacks while the sinkers were at work, but the tubbing plates were never put in place while the men were below them. The relative position between the cutting shoe and the shaft bottom varied according to the nature of the ground.

The difference was at times considerable, but at other times, owing to the hardness of the ground, or to a large boulder being encountered, the shoe had to be exposed and a way made for it. In such cases the practice was to excavate the middle, leaving about a yard of strata round the side of the shaft, and, when the pressure was put on the tubbing, this ground was all pushed toward the middle of the shaft. Again, on account of the ground being at times hard under one part of the shoe and soft in another and owing to the importance of the tubbing being kept as level as possible, especially until the cutting shoe was well below the anchor ring, it was often necessary to use the hydraulic jacks on one side only.

Where the ground was treacherous, the cutting shoe was always well below the shaft bottom, and at no time was trouble experienced from collapsing sides. A feature of this system was that, although the tubbing weighed at the completion of drop-shaft process 514 tons, in no case did it travel down without the aid of hydraulic pressure, except, when the tubbing was first built inside the brickwork.

The water which at times exceeded 15,000 gallons per hour, caused trouble by the sand and small debris obstructing the pumps. When the shaft became too deep to pump to the surface in one lift, tanks were slung and the lift divided.

At No. 1 pit until October 18, 1908, the cutting shoe would hardly move, and on making an examination it was found that sand had risen about 10 feet in the shaft, giving a head of about 24½ feet above the cutting shoe. This quicksand was too soft for men to work in, so the water was allowed to rise some feet in the shaft, and a grab bucket worked through it. When some of the sand had been taken away, the tubbing was pushed down another 22 inches.

The inrush of sand greatly interfered with the pumps, which had to be overhauled, and it was not till a year later that the shaft was again cleared of water and the ground became more solid. On making an examination it was found that a large cavity had been formed on the bore hole side of the shaft, through which large quantities of sand were being washed up from below and behind the cutting shoe, which was 16 feet 4 inches in advance of the pit bottom. This continued inrush of sand caused a subsidence of the surrounding ground, and as the only means of stopping it was pushing down the tubbing, which could not be done without liberating the cutting shoe that was partly embedded in hard clay, some means had to be found to stop temporarily the inrush. It was decided to lower a few tubbing plates in front of the cavity, and against these plates to place a large number of bags containing concrete. After considerable delay and trouble, sufficient clay was removed, the tubbing pushed further down, and the quicksand entirely cut off.

A most serious danger then appeared. The inrush of sand had caused a bad subsidence on the bore hole side of the shaft. The 24-inch diameter bore hole, which had been put down before starting the sinking, was close to the shaft. When lowering the lining tubes into this hole, the contractor unfortunately jammed them fast and caused them to buckle. It took 4 months to cut through the obstruction, and during this time a large cavity must have been formed about 100 feet from the surface which, however, did not affect the surface until the sand rushed into the pit from the same area. This subsidence was so unequal that the large brick thrust pillar round the top of the shaft showed signs of tilting over toward the bore hole, and a cavity was formed on this side under the concrete block which extended to the brickwork of the shafts. To prevent the thrust pillar from tilting over, large quantities of cast iron tubbing plates and other weights were put on the brick pillar on the opposite side to the bore hole, and the cavity was flooded with thick liquid cement day and night. The total falling away of the ground below the concrete block was about 2½ feet.

Before the pillar had ceased to move, the 4-inch anchor bolts were about 7¾ inches from the perpendicular in a depth of 28½ feet, and the authors were quite convinced that it was owing to the good and careful building of the masonry, the strong reinforcing of the concrete block below, the tight screwing up of the anchor bolts, and the oblique holding down bolts extended from the pressure ring to the outside of the masonry, that the pillar was able to withstand the strain.

The chief object was to push the tubbing down into the Permian marls before the pillar could tilt over to such an extent as to cause the 4-inch anchor bolts to bind so strongly against the tubbing as to make this impossible.

After the tubbing had been pushed down through the drift, and as far as possible into the Permian marls, temporary safety bolts were put between the pressure ring and the top ring of tubbing, so as to prevent any possibility of the tubbing slipping down; but, when the shaft bottom had been taken from underneath the cutting shoe, and there was a total weight of 514 tons above it, the friction and pressure of the surrounding strata were more than enough to keep it from moving downward.

It was intended to take the pressure ring which cost $1,975 and the top lengths of anchor bolts to No. 2 pit; but, owing to the danger of the pillar breaking whilst subsidence was still going on, it was decided to leave them in.

On examination, the steel cutting shoe was found at the finish to be absolutely as good as new. This shoe which cost $1,725 was so designed that it could be taken out for use in No. 2 shaft, but it was decided to leave it in No. 1 shaft as the ground behind it was not sound.

A special tubbing ring was then ordered to form a water-tight joint between it and the cutting edge of the shoe. The cutting shoe and this ring were held together by bolts, and the joint made with the usual wooden sheeting and wedges. The method of suspending the tubbing to the shoe is shown in Fig. 15.

In pushing down tubbing, the only guide to keeping it perpendicular is the distance between the anchor ring and the pressure ring. It is, therefore, quite possible, especially in loose or inclined strata, that tubbing may vary somewhat from the vertical. To allow for such variations, in the drop-shaft portion of the sinking the tubbing had an internal diameter of 23 feet, the tubbing below has an internal diameter of 21 feet. On plumbing, the tubbing was found to be 3⅜ inches out of the vertical, so the special tubbing ring was made $^{11}/_{16}$ inch longer on one side than the other. Two conical reducing rings were then put in to bring the diameter to 21 feet, and they also provided a reliable support for the tubbing. The center of the bottom ring was then projected on to the doors at the surface, and now acts as the center line for the rest of the sinking. The hydraulic jacks, the scaffold at the top, the electric crane, and the circular H girder, were then removed to No. 2 pit, and at the same time the girders and heavy lifting tackle were placed across No. 1 shaft for the large pumps which had to deal with the water in the sandstone rocks still to be sunk through.

The drop-shaft process of sinking being completed, the rest of the tubbing was put in on the underhanging principle. The thickness of the tubbing plates were as follows:

From a Depth of Feet	To a Depth From the Surface of Feet	Thickness in Inches
114	204	1½
204	283	1¾
283	264½	2
364½	433½	2 3/16

This tubbing instead of having a smooth back as in the case of the drop-shaft process, had on each plate three slightly projecting lugs, shown in Fig. 16, in order to present an uneven surface to the grout to be poured in behind, and so make each length of tubbing self-supporting.

As soon as 5 feet of sinking had been carried out in the usual way, the first ring of underhanging tubbing was put in and bolted to the lowest flange of the conical rings, lead sheeting being placed between all the joints. In order to insert the closing segment of each ring, rather more ground behind it was taken out, so as to allow it to be pushed back and then brought forward into its place. All was then bolted up tight and calked.

The sinking was again continued, and the ordinary brick scaffold placed on the bottom of the shaft. After the next ring of tubbing had been placed and bolted in position, wooden segments were placed against its lower edge to fill up the space between the tubbing and the sides of the shaft. These, provided with slotted holes, as shown in Fig. 17, were pushed back as far as possible against the irregular sides of the rock, and fastened with temporary bolts to the bottom ring of tubbing. To fill the irregular spaces, wooden wedges and old brattice cloth were pushed in. This packing while not a water-tight joint, held the grout, and when completed the scaffold was raised and grout poured behind the tubbing, through oblique holes made for the purpose shown in Fig. 16. The grout, mixed in the proportion of 1 of cement to 3 of sand, was sent down the shaft dry, for it was found that if the water was added at the surface the result was not satisfactory. The water was allowed to flow to the shaft bottom through pipes fixed in the oblique holes, until the time was opportune to plug them. By the time that the shaft had been excavated for another ring of tubbing, the grouting had set sufficiently to allow the wooden distance pieces and packing to be taken out.

The writers tried mechanically mixing water with the cement and sand and running the mixture down the shaft in iron pipes, but this plan was a failure.

To guard against sudden outbursts of water, a bore hole was kept in advance of the pit bottom, but it was not until a depth of 283 feet was reached that it became necessary to work the pumps, the water up to that time having been lifted in the bucket. A second water feeder was met at a depth of 292 feet, the total quantity of water from these two feeders being about 30,000 gallons per hour. The water interfered with the grouting, because as fast as the liquid was poured through the oblique holes it was washed out again, owing to the pressure of water at the back of the tubbing. Under these circumstances it was necessary to abandon the attempt to grout; but when the length of tubbing hanging more or less free was considered insecure, a V ring, Fig 16, was placed on wooden sheeting until a fairly impervious stratum was reached, which, when wedged, prevented the feeders of water from above coming out below the ring, and also served as a support for the ungrouted tubbing above. As the water rose behind the tubbing, and came through the holes in the segments, it was conveyed to the bottom of the shaft in pipes. The two rings of tubbing placed under the V ring were therefore in practically dry ground, and were successfully grouted. When it was thought that the grout had set sufficiently, the holes above the V ring were plugged; and, as an ex-

periment, the holes in the V ring were kept open, to ascertain whether the pressure of the water could be kept back by the wedging alone. It was found, however, that it did not keep the water back, but when the holes were plugged, the grouting, which by this time was hard, held back the whole of the upper feeders. The water coming from fresh feeders below was then only 5,000 gallons per hour.

The greatest advantage in underhanging tubbing arises from the fact that in most water bearing strata there are always layers which are impervious, or almost impervious, to water, and it was frequently found possible to cut off quite large feeders from time to time, so that the pumps had never to deal with more water than 35,000 gallons per hour. For instance, when the shaft was at a depth of 379½ feet, a feeder of 25,000 gallons per hour, was successfully dealt with, without resorting to a V ring. This, however, proved very difficult, as the pressure of water washed out the grout, which seriously interfered with the pumps. Another considerable advantage in this class of tubbing is that no skeleton rings are required.

A cause for anxiety in connection with building down the tubbing lay in the fact that the plates had to be fixed close to the pit bottom, and consequently had to resist the force of the blasting. Fortunately, however, there was never a single breakage. Another point that might be mentioned is that although the work of building tubbing was delicate, no accident of any kind happened.

By the time that the sinking had gone through the sandstones, the quantity of water coming down through the pipes fixed in the lower part of the tubbing amounted to 7,500 gallons per hour. It was decided to sink a little lower until a bed was reached on which it was possible to place an English wedging curb. When this depth was reached, a last ring of German tubbing was put in, with a specially strong flange to resist the wedging.

Whilst this work was going on, the water was conveyed into a half-moon tank slung in the shaft side from the tubbing, and thence was pumped to the surface. The pit bottom was therefore fairly dry. The wedging curb was laid at a depth of 446 feet 2 inches from the surface on a bed which was not entirely satisfactory, as it consisted of dark shale on one side of the pit, and strong impure fireclay on the other side; but confidence was placed in the grout and concrete behind the English tubbing, rather than in the wedging curb. The concrete was mixed in the proportion of 2 of broken bricks, 1 of sharp sand, and 1 of cement. The wedging curb was laid after it had been keyed up to the German tubbing. After all the holes through which water was running were plugged a gauge on the bottom ring of German tubbing showed a pressure of 40 pounds per square inch, and the water spurted out of the weak places in the joints of the English tubbing, and also under the wedging curb. The plugs were taken out, pumping was resumed, and the second wedging curb was laid on October 28, 1909, on a bed of flaggy rock 12 feet 10 inches below the first, the English tubbing built up, and concrete rammed in behind. To give this concrete more time to set, pumping was continued 1 month. A pressure gauge was then fixed in the bottom series of English tubbing, and the water was again plugged off. It was some considerable time before the gauge showed any signs of rising, indicating that there was very little water passing the top wedging curb. When the pressure rose to 50 pounds per square inch, water came oozing out in the weak places in the joints immediately above the bottom wedging curb. This was rather disappointing, as it proved that the lower concrete, which had been allowed to stand for a few weeks, would not of itself hold the water back; it was, however, stopped by further wedging, and when the gauge recorded a pressure of 60 pounds per square inch it was noticed that water had started to spray through the rock 6 inches below the wedging curb, although there seemed to be no leakage immediately under it. The pressure rose to 100 pounds, and a gauge was again put higher up on the bottom ring of German tubbing.

The pressure on the top gauge was regulated by the quantity of water pumped at No. 2 pit, 285 feet to the east of No. 1 pit.

As the leakage of water in the strata below the curb was so small, it was decided not to put in a third series of English tubbing, but to sink down very carefully for a distance of 36 feet below the tubbing, and to build up brickwork set with cement to the bottom wedging curb, so that at any time, if it became necessary to build a third series of tubbing, the curb could be set on cement brickwork, and the ground kept intact.

The little water that was spraying out through the rock apparently soon ceased, and since the tubbing has been thoroughly calked the shaft is quite dry.

The shaft from the cutting shoe to the center of the bottom wedging curb is only 1 inch out of the perpendicular.

It is interesting to compare the cost of the German and English tubbing. The former in the bottom section was $2\frac{3}{16}$ inches and the latter $2\frac{1}{4}$ inches thick. Although the cost per ton of the English tubbing was $10 cheaper than the German for the thicknesses above mentioned, the cost per foot was higher. The English tubbing weighed considerably more than the German, owing to the fact that the Germans used no vertical flanges except those for bolting. The actual costs were: English tubbing, $140 per foot; German tubbing, $130 per foot; or $10 per foot in favor of the German tubbing.

The Worsley Four-feet coal bed was reached in No. 1 shaft at a depth of 772 feet 4 inches from the surface, and from the bottom of the English tubbing to that point no difficulties were encountered.

Dangerous Months in Coal Mining

H. N. Eavenson, E. M., Gary, W. Va., presented a paper at the Pittsburg meeting of the American Institute of Mining Engineers which contained probably the most complete list of coal-mine explosions in print. As many mine explosions are mere history, and their historians failed to state whether they were due to gas or to dust or to a combination of the two, it is out of the question for any one to separate them, except in the anthracite fields, where all explosions are from gas, since anthracite dust has not been exploded.

In this analysis of Mr. Eavenson's paper no account is taken of the gas explosions in anthracite mines for the reason mentioned and because in the 73 years covered by the table only four explosions in these mines have claimed a death toll of 10 or more at one time.

It has been observed that bituminous mines become more dry and dusty during those periods of the year when the air outside is cooler than the air inside, and therefore on entering the mine absorb moisture from the mine and coal; also, when the outside air is warmer than the mine air and therefore deposits moisture on entering the mine, and then warming to mine temperature absorbs moisture from the mine and coal. With these facts in mind the writer grouped the coal mining states where the hygrometric conditions of the atmosphere would be approximately similar at the same periods of the year, and took from Mr. Eavenson's table the months in which explosions caused the death of 10 or more.

To verify the assumption that in certain localities explosions were more apt to occur in certain months, a second tabulation was made for all explosions in which five and less than 10 were killed.

The results of these analyses are given in Table 1 which should be carefully studied by coal mine foremen and managers.

It requires several days for a mine to become very dry and dusty, and this shows the aid that can be had from hygrometer readings, as well as temperature and barometer readings.

TABLE 1. DANGEROUS MONTHS IN COAL MINING

Oblique lines (/) represent accidents when over 10 were killed; horizontal (—) 5 to 10

	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alabama Tennessee Kentucky	— / =	///— /=	— /	// =	/ //			/		—	— /	/ /
10+	1	4	1	2	3	0	0	1	0	0	1	2
5+	3	3	1	3						1	1	
S. W. Virginia West Virginia Pennsylvania Ohio, E.	— //////— //=	 //— /— —	// ////— /=	 /— /— /	 //	 //—	— = ///=	 —	 / —	/ — //=	/ //= ///=	 // ///
10+	8	3	7	3	2	2	3	0	1	3	6	5
5+	4	3	4	2		1	5	1	1	3	4	
New Mexico Colorado Wyoming Mexico Alberta	 ////— /—	/ /// //	 //// /	— /		— / /	 —	 /	 /— /	/ //	 /	/ /
10+	5	6	5	1	0	2	0	1	2	3	1	2
5+	2	0	0	1	0	1	1	0	1	0	0	0
Washington British Columbia	/ =	 /		/—	/ /		 /			/// /	/ /	/ /
10+	1	1	0	1	2	0	1	0	0	4	2	2
5+	2	0	0	1	0	0	0	0	0	0	0	0
Indiana Illinois	 //	 —		 /						 —//		 =
10+	2			1						2		
5+		1								1		2
Iowa Missouri Kansas Oklahoma	/ //—	 / — —	— /	 //=						 /	 / /	
10+	3	1	1	2	0	0	0	0	0	1	2	
5+	1	2	1	2	0	0	0	0	0	0	0	

On the Atlantic Coast, 75 per cent. of the explosions in eastern Virginia occurred in May, also 28.5 per cent. of the Nova Scotia explosions.

In February, 25 per cent. of the explosions in eastern Virginia occurred and 42.8 per cent. of the Nova Scotia explosions.

On the Pacific Coast, explosions favor the months of October and January, although May, November, and December have two each in Washington.

The coals mined in West Virginia and Pennsylvania, where the majority of the explosions have taken place, are friable coking coals. Those which are semibituminous seem to be more susceptible to oxidation and air slacking than coals containing more volatile matter. Colorado explosions have occurred mostly in coking coals and those that are friable. The block coals of Ohio, Indiana, Illinois, and western Kentucky are not so liable to air slack and create dust, as the more friable. In justice to Pennsylvania and West Virginia operators, it is stated that coal has been mined longer and there are more mines in coking coal in those states, therefore more explosions.

Attendance at the University of Illinois

The number of students registered in the College of Engineering of the University of Illinois on November 1, 1914, is reported as follows:

Architecture, 157; architectural engineering, 197; civil engineering, 201; electrical engineering, 277; mechanical engineering, 263; mining engineering, 41; municipal and sanitary engineering, 36; railway engineering, 30; total, 1,202.

This statement does not include the number of engineering students registered in the Graduate School.

A Plea for the West Virginia Miner

Uplift Work Amongst the Native Mountaineers Who Constitute a Large Part of the Miners of that Region

By Marguerite Walker Jordan

IN THE course of my studies at Columbia University, I heard much of Ellis Island, that door of hope to the yearly increasing multitude of immigrants, and much concerning the obligations which we owe to these our foreign brothers.

Ellis Island, however, is not the only place that challenges our sense of duty to our fellow man. Being a native of the Southern Alleghany Mountains where the purest Anglo-Saxon blood of the world is found, and where in recent years, with the opening of vast coal operations, communities have suddenly sprung up with their attendant chain of serious problems, both social and economic, I am naturally strikingly impressed with a sense of duty to our brother in that section and I have been wondering what we are doing to uplift him.

The man who makes up the mining population of the West Virginia camps is a type which for generations had been isolated in the mountains where hunting wild game and chopping timber "offen his patch" were the only sources of livelihood. But today his patch is no more. An absent owner cut the timber from the whole range and sent the mountaineer with pick and shovel under the surface to dig coal. Literally buried from sight of sun and progress, no one seems to know him. Little thought had been given to his welfare and uplift, until a strike, followed by bloodshed, brought him prominently to attention. Then the declaration of martial law in West Virginia, followed later by the memorable occurrence in Colorado, which now occupies so much of our attention, made the miner, his life, conditions, and surroundings the topic of the hour.

WEST VIRGINIA MINERS' CHILDREN

The world generally does not know of these people and, what is more, few people have seemed to care to investigate.

I was particularly fortunate in getting my information first hand in the field itself. My sense of fair play was aroused by the false opinions and unjust criticisms of people who know nothing of the actual situation in these mining communities. I realized that to learn and know conditions is to *live* in them. Therefore, with the two-fold object of both learning and improving conditions, I went into several of the typical mining towns, taking with me two special teachers in home making, with a view of securing the confidence and interest of parents through effective work with the children.

The coal operators were favorably inclined toward the experiment. Owing to my inexperience, I could outline the work only vaguely in the beginning. But from the day of our arrival we aimed to bring something of happiness, contentment, and economy into the homes of the community. We saw at once that the situation would demand tact, patience, and above all else, no outward affiliation with the company itself, for the operator as an operator is sincerely hated.

The place we chose for the beginning of our work was on a branch of the Virginian Railroad known as "Winding Gulf." Four years ago it was virgin forest, but now little mining towns have sprung up like mushrooms all along the steep denuded mountain sides. We were to work in a series of three of these towns, strung along the gulf about 2 miles apart.

Thus it was that on a hot August day, three University girls found themselves in a dirty little street of a dirty little town, surrounded by dirty little children and grunting pigs. The question of at least temporary accommodation was soon solved. We approached the one building which was somewhat more pretentious in size than its neighbors. We assumed the role of teachers and began to organize sewing and kindergarten classes. In this way we finally got started, though at first we had considerable trouble.

Our calls on the neighbors began immediately. Most of the faces were unsmiling and stern, but they showed us the hospitality of "have a tater, stranger." One dear woman wished us "succession"; another showed us her "photographs." One man proudly brought out the gun

and hound which he had received in exchange for his last wife. We became acquainted and our room on the third floor of the boarding house became a class room. Boys up to 13 years old came to that "kindergard" school. With their help we cleared the space for a playground. Their fathers moved the heavy timber left by the lumber men, and built swings. Later, this cleared space was used not only by the children but as an assembly room for evening socials and outdoor classes. The work in the other two was carried on along similar lines and always with patience and with almost immediate interest and enthusiasm on the part of the children.

With the women, we were not so successful. A coal town is of necessity dirty. Water must be carried and house work is not systematized. Pay day was announced every 2 weeks by the drinking of whisky, playing of cards, and the flourishing of pistols. On these occasions, we kept a nightly watch, sitting on the edge of our wire cots very close to our thin lockless door. The hours never dragged at such times for "our men folks liked a good time." These little amusements made our lives interesting and, at times, exciting. Besides, the condition of the food and the wretchedness of the sanitation offered little to make living pleasant. Accordingly we were glad to find in the next town a fairly comfortable four-room house.

The valley consists of a creek with a railroad on both sides. The mountains rise almost perpendicular; the sun beats fiercely down at noon and in the evening drops quickly behind the mountains. Often while walking home from work along the lonely stretches of the valley in the somber dusk we, with faces blanched with fear, would pass negroes or Italians. At such times we would bolster up courage by humming a tune, the favorite being "I've Been Working on the Railroad." But no matter whom we met, the "howdy" was always passed and the hats would invariably come off. In time we became known by such names as "Mrs. Teachers Nice" or "Quality Ladies." The distance we had to cover took much of our time and energy. This gave us much concern for we saw an ever increasing number of things to do, but we realized our time and strength were limited.

We taught something of course, and sowed the seed for effective future work, but we learned more than we ever taught and received more than we ever gave.

We were forced to admire the conservatism and shrewd native ability of the mountaineer. We saw at once that knowledge for them must be simple, definite, and shorn of all artificialities. The domestic science of a white marble kitchen left me somewhat at sea when I found myself equipped with nothing but a "two-eyed coal stove" and a frying pan. I didn't give up for I realized that much is spent unwisely in equipment and that the problem of more wholesome and attractive food and greater efficiency and economy in cooking were to play a vitally important part in the ultimate success of the work which I had undertaken. At this stage I realized that I was fortunate in having the cooperation of Mrs. Anna B. Scott, of Philadelphia, whose 40 years of experience in teaching the wage earner better and more economical cooking and home making have made her recognized as an expert authority in this important work. The interest which her remarkable demonstrations aroused in the community among men as well as the

MISS JORDAN'S FAVORITE RESIDENCE

Even Providence itself seemed at times to be allied with other forces in trying our mettle, for we continually worked under great difficulties and it was only our ability to see the amusing side that often saved the situation.

In one town the building which we expected to use was not completed; an available school house, too small; another school closed on account of diphtheria. In that same town, a well-equipped building which was offered to us, burned. Drizzling fall rains and the earliest snows for "well nigh 40 years," made walking bad and a playground impossible.

In addition to all these handicaps there was marked opposition from local mountain teachers and school boards who had never heard of manual training, domestic art, or science. Naturally then, we were forced on account of this opposition, to confine ourselves to evening club work.

women, employers as well as employes, gave me a new light and inspiration on the great ultimate possibilities of such work in a field like this.

Before anything can be taught, even to children, the desire to want must first be instilled. We want because our neighbors have, but in this community, lacking the education of environment, even that of the newspapers and department-store windows, there is little to want. Your neighbor lives as you do. Life down there is a very simple, very elemental process. The people talk little and they have gradually become like the mountains that surround them, reserved, conservative, showing neither pain or pleasure, suspicious of all strangers and anything or anybody connected with the company. Socialism there becomes violent anarchy. No demands are made by union leaders for better schools, hygiene or sanitation, but always for an increase in wage. Neither the man nor his wife knows how to make a dollar do a dollar's work. The wage increase goes for gambling and cheap whisky. One even sees a native driving mules on Monday morning in $6 patent-leather shoes which were purchased Saturday evening. The best grade of food stuffs is demanded and much of it ruined in the preparation or thrown out the back door. This extravagance is responsible for a large part of the discontent. It is the old, old story of "the high cost of ignorance."

The only hope for the situation is education. These people must be brought back to the simple, sensible way of living and be shown that work is a blessing, not a curse. We must teach mothers how to prepare wholesome, economical food. The task is a difficult one, requiring money, ability, skill, and patience. But it can and will be started and accomplished when capital realizes its importance and possibility.

The coal operator, as any other business man, must see a profit for his investment. He is neither a philanthropist nor a missionary. His position differs from that of the New England mill owner in that he did not create the present conditions under which he works. When people in the city talk of those terrible mines, I wonder if they know of their own department stores, which are supposedly model, and the factory and child labor laws, which should be enforced. A maid in their own kitchen may be finishing a 10- or 12-hour day. The whole thing seems to resolve itself to this, that we are often conscious of the evils of the labor question in the distance but not in our own home and environment.

When the ambition of the mountaineer is aroused, he seldom goes back. It is true that we were never quite sure just how our work was received, and because there was no outspoken appreciation, we could not tell what lasting impression we had made. Some time after leaving, however, I wrote the Camp Fire Girls about some work I was doing in one of the paper-box factories in the North, and in a few days I received a large soft package which contained hundreds of short-stemmed mountain violets, tied into small bunches with calico strings. The note accompanying them read: "You showed us as how they were pretty and we reckon the girls up there don't have none."

The whole problem, after all, is teaching the laborer how to live. Simple, wholesome food makes a man better physically and mentally. A warped mind and soul may be the direct result of food and home surroundings, and corporations today are beginning to realize that the efficiency of a plant depends not only upon the latest improved mechanical inventions, but upon the food and care of the man who works in that plant.

To summarize what I have said, my object has been to outline conditions as they exist in the West Virginia and other mining towns, to tell what we tried to do to help the people there and to make an appeal, as far as it is expedient, for improving conditions in the future.

The Methanometer

Written for The Colliery Engineer

The causes of coal mining disasters are roughly three in number: the first being explosion from firedamp and coal dust; the second, failure of the human element as a factor in securing mine safety; and the third, bad light, exposing the miner to continual danger from falls of roofs and sides, and also to nystagmus. Of these, the first is probably the most potent cause of trouble. Firedamp and coal dust are the two causes of mine explosion, and of these the primary and greater cause is almost invariably firedamp. Coal dust floating in the air as an impalpable powder is a powerful and dangerous element in the explosion, because mixed with firedamp it increases tremendously the violence of the blast and renders its effect far reaching, but although coal dust alone may cause a very destructive explosion, it does not ignite so easily as firedamp, nor does the violence exhibited appear to be so great as when in combination with the gas. Firedamp therefore remains the main cause of all great explosions.

It is perhaps hardly necessary to enter very fully into the cause of firedamp explosions, but in order to render the subject complete, it may be briefly noted that firedamp, technically known as methane, is a light carburetted hydrogen gas, closely akin to marsh gas and invisible and odorless. In the proportion of 5½ per cent. in ordinary air, firedamp forms a highly explosive mixture, but in mine air in which impalpable coal dust is almost always floating, 2½ per cent. will, and a much smaller proportion may, form an explosive mixture of a most deadly and destructive character. Moreover, modern conditions of coal mining have apparently given explosions a fierceness and destructive violence quite unknown to the earlier days of the industry, owing to altered conditions. Top seams are becoming worked out, shallow seams where little or no gas ever occurs are nearly all worked out.

As the mines go deeper, gas becomes more abundant, and moreover, the workers in a modern pit are numbered by the hundred as against a few score that in former times were exposed to the danger of any one calamity.

For these reasons, it is interesting to refer to an instrument known as the "methanometer," developed in Great Britain by Mr. Alfred Williams, and recently demonstrated in London.

The principle of the Williams methanometer is interesting, as it is the first apparatus ever produced which puts to a complete practical use the strange property peculiar to platinum black. This property is that in an atmosphere containing firedamp, it exhibits a rise in temperature, this rise always consistently coinciding in its intensity with the amount of firedamp present. Hitherto attempts to make a practical use of this property of platinum black of any real value failed, because of two seemingly insuperable difficulties. One was to provide an indicator of the temperature rise that was at all reliable and which actuated thereby would instantly and accurately show the percentage of firedamp in the atmosphere; the other difficulty was that, when cold, platinum black is very insensitive to small percentages of firedamp, while it was imperative that these small percentages should be recorded if mine safety is to be completely secured. In order to overcome this, a detector arrangement of platinum black held always in contact with the mine air is kept to such a high degree of sensitiveness that it instantly responds to the smallest possible percentage of firedamp that may present itself. In the second instance, by an ingenious application of the principle of the thermo pile, as soon as the sensitized platinum-black detector responds to the presence of firedamp a specially designed galvanometer actuates the pointer, which traversing the scale minutely calibrated by means of mine gas, shows at a glance, and to a fraction, the percentage of firedamp at that moment in the pit atmosphere. This scale and pointer can be fixed at any distance from the plate at which the platinum black detector is operating, and a convenient situation, as for example, in the mine manager's office on the surface. Distance makes no difference to the quick response of the pointer, or to the accuracy with which it turns to the figures on the scale indicating the gas percentage in the pit. Hence an official in the manager's office can see at a glance, at any moment of the day or night, the condition of the atmosphere of the mine. If a danger point is reached, in addition to the visible signal, a bell is rung. In addition to this, the automatic recorder registers the varying percentage of the firedamp at every instant in the mine on a chart showing days and hours. In addition to the fixed type a portable methanometer can be used by the fire boss who has to see to the safety of the mines. This is so constructed as to allow of its being raised roof high and inserted in the crevices. If gas is present in the workings, it is at once detected and the percentage indicated on the dial of the instrument.

The established means which fire bosses have at present for detecting firedamp, is the safety lamp, which is an uncertain and often decidedly dangerous means of discovering trouble. By the amount of visibility in the cap, the fire boss gauges, or rather roughly guesses, the percentage of firedamp in the mine air, and makes his record accordingly. Any slight defect in the eyes of the fire boss would affect his work as to the cap visibility or even prevent his seeing a low percentage cap at all; also several observers of one cap are likely to differ in their intensity estimates. Moreover, a safety lamp is often a dangerous means of testing for gas. When a perfectly formed cap is seen the safety lamp must be handled with caution, moved slowly to a place of safety, and must on no account be jerked or rapidly moved, because such treatment is likely to ignite firedamp outside the lamp and cause an explosion. Moreover, although in some mines the amount of firedamp may be generally so small that it cannot be detected with an ordinary safety lamp, it may give rise to a danger, owing to the presence of coal dust and other reasons. Again, firedamp will sometimes develop in dangerous quantities in a mine atmosphere, and therefore a constantly automatic record, indicating at once, is highly necessary. For these reasons the methanometer appears to be a most valuable instrument. It has been favorably reported upon by two well-known British scientists, Prof. Silvanus P. Thompson, and Dr. J. Erskine Murray, and we are indebted to Mr. G. MacElwee, of Norfolk House, Strand, London, for particulars concerning this valuable device.

Culm Piles Disappearing

The piles of culm and waste rock which break the sky line throughout the anthracite region of Pennsylvania are now being made to serve a very useful purpose. There is at present a market for almost any grade of anthracite that will burn, and no more coal goes to the culm bank except for temporary storage and subsequent recovery by washers. These artificial hills, once considered refuse, are contributing their share to the total coal production and are rapidly disappearing. Even the second washings are being utilized and flushed into mines to partly fill old workings and furnish support to the roof after which the coal previously left for pillars is removed.

To insure good mine ventilation at a minimum of cost, see that the airways are large and kept free from rock falls and obstructions such as cars standing on the entries when they should be in rooms or at partings; also that the air splits established are not interfered with by leaving doors open, removing brattice, and obstructing regulators or any other means.

Preservative Treatment of Timber

Seasoning—Material Used for Treating and the Methods of Applying—Tests for Absorption

By J. M. Goldman*

IN ALL processes for the preservative treatment of wood, the kind and ultimate use of the wood as well as the degree of dryness must be considered. In the use of wood as timber for structures, it has been found that coniferous woods serve best where lightness and stiffness are required; dense coniferous woods, where steady loads are to be supported, and tough hardwoods where there are jarring loads.

Seasoning is commonly understood to mean drying, but in addition to expulsion of water by evaporation other changes take place, such as the drying and partial decomposition of albuminous substances of the sap contained in the cells, leaving the seasoned wood more porous, but with less fermentable matter than when green. The time required for timber to season, cut at different periods of the year, has been determined by Forest Tests as in Table 1.

TABLE 1

Species	Location of Test	Time Required for Seasoning			
		Spring Cut	Summer Cut	Autumn Cut	Winter Cut
Chestnut	Parkton, Md.	5	4	8	7
Southern white cedar	Wilmington, N. C.	3	3	8	5
Northern white cedar	Escanaba, Mich.	12	9	7	6
Western red cedar	Wilmington, Calif.	{ 4	5	3	3
		3		7	4
Western yellow pine	Madera, Calif.	5	6	6	6

TABLE 2

Species	Duration of Seasoning	Green, Weight Per Cubic Foot	Seasoned, Weight Per Cubic Foot	Weight Lost	Total Weight Lost Per Pole	Average Volume of Poles
	Months	Pounds	Pounds	Per Cent.	Pounds	Cubic Feet
Chestnut	4-8	56	47	16	180	20.00
Southern white cedar	3-8	a37	26	30	228	20.76
Northern white cedar	6-12	33	25	24	141	17.62
Western red cedar	3-5	b33	25	24	219	27.34
Western yellow pine	3-9	65	33	49	835	26.10

2. The artificial methods of seasoning are kiln, steam, and hot-air drying. The practice in all these methods is to heat the timber, thereby reducing its hydroscopicity and tendency to warp, neither of which, however, can be altogether overcome, even with prolonged exposure to temperature below 200° F., which is found to be the maximum permissible, higher temperatures by volatilizing components of the woody fiber being injurious to the strength of the timber. The following temperatures have been successfully used and are recommended for drying without injury to the wood:

For oak and ash.................... 120 to 130° F.
For poplar......................... 158 to 180° F.
For walnut......................... 90 to 100° F.
For white and yellow pines.......... 160 to 190° F.

Table 2 shows weight lost by seasoning until approximately air dry.

Seasoning by allowing the smoke-laden products of combustion to circulate among and penetrate loosely piled timbers has been found an excellent aid in their preservation. The saving in freight effected by seasoning is illustrated in Forest Service Tests as shown in Table 3.

3. Under average conditions, the agencies of destruction of timbers are relatively as follows: wear, 5 per cent.; breakage (overload) and fire, 20 per cent.; decay (and insects), 50 per cent.; all other causes, 25 per cent. Decay and insects are thus seen to be the greatest source of damage, and when attacked by either or both, timbers frequently are dangerously weakened and break in service. The danger from these causes being two and one-half times greater than from fire, their elimination may justify any reasonable cost of treatment.

TABLE 3

Species	Seasoned Poles Required for Mine Carload, 40,000 Pounds	Total Decrease in Weight Due to Seasoning	Saving in Freight on Carload Lots	
			25c. Rate	15c. Rate
Chestnut	43	7,700	$19.25	$11.55
Southern white cedar	74	16,900	42.25	25.35
Northern white cedar	91	12,800	32.00	19.20
Western red cedar	59	12,900	32.25	19.35
Western yellow pine	46	38,400	96.00	57.60

4. Impregnation of timber with zinc chloride alone is one of the earliest and best known methods of timber preservation, but zinc chloride is not wholly resistant to fire, and a number of mineral salts, such as aluminum phosphate and sulphate, ammonium chloride, ammonium phosphate and sulphate, sodium tungstate, and boric acid, have been used therewith as an aid in fireproofing.

Owing to the fact that the spores of the fungi (*merulius lacrymans*) or "dry rot" thrive in the presence of ammonia or its compounds, and cannot germinate without a certain amount of moisture, it is not advisable to use any salt containing ammonia or one which is highly hydroscopic. Moreover, ammonium phosphate, in addition to its high cost (11 cents per pound) is adaptable only to a high-pressure process for thorough impregnation; ammonium chloride is exceedingly hydroscopic, and imparts the same property to the treated wood. These characteristics would seem to render the use of ammonia inadvisable.

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The sodium tungstate is a good fireproofer, but its use is also limited because of its high cost. Boric acid forms white crystals over the wood, during the process of impregnation, around the steam coils and thermometer bulbs, thereby preventing accurate determination of temperatures; otherwise it is an efficient preservative from fire.

5. Aluminum sulphate, $Al_2(SO_4)_3$ known commercially as "white sulphate of alumina," is recommended by many, for use both as a preservative and for fireproofing, due to its heat resisting qualities, and its low cost of 2 cents per pound. This salt, when used in fireproofing, should be neutral (neither acid or basic), free from salts of sodium and potassium, and should not contain more than 1 per cent. of iron; also, it should be granular and crushed to 40 mesh or finer. In the presence of zinc chloride and free from alkali, aluminum hydrate will not precipitate in the tank solution, especially where a 1-per-cent. solution of aluminum sulphate is used. The relative solubility of 1 part aluminum sulphate in 100 parts of water at different temperatures is given in Table 4.

Table 4

Cent.	$Al_2(SO_4)_3$	Cent.	$Al_2(SO_4)_3$	Cent.	$Al_2(SO_4)_3$
Deg.	Per Cent.	Deg.	Per Cent.	Deg.	Per Cent.
0	31.3	40	45.7	80	73.1
10	33.5	50	52.1	90	80.8
20	36.1	60	59.1	100	89.1
30	40.4	70	66.2		

The strength of aluminum sulphate in solution can be quickly ascertained from the specific gravity of the solution as shown by Table 5.

6. Zinc chloride as a wood preservative should be free from oxychlorides and other impurities, should be neutral and not contain more than 1 per cent. of iron nor less than 96 per cent. of fused chloride of zinc. Zinc chloride is soluble in clean cold water, and is suitable for use in open-tank treatment of timber. The commercial form of fused chloride "butter of zinc" is a transparent white mass, specific gravity 2.75, very hydroscopic, soluble in alcohol, melting at 100° C., and distilling at a low red heat. It is a powerful caustic, drawing water from organic substances and carbonizing the wood, and in concentrated solution will parchmentize paper. It is also a germicide, killing insects and the spores of dry rot. The purity of the salt, either fused or crystalline, can be determined by testing for free acid, solubility, and specific gravity, using Kramer's table, Table 6:

7. The chemical composition of different woods has been under investigation for many years, but as yet it is little understood. It is claimed by some that when treated with zinc chloride a part of the salt enters into and forms a permanent combination with the cellulose of the wood. This, however, is doubtful, especially where weak solutions are used; the crystallization of the salts in the fibrous interstices of the wood cell walls is a more reasonable explanation.

Table 5

Per Cent.	Specific Gravity 25° C.	Specific Gravity 35° C.	Specific Gravity 45° C.
5	1.0503	1.0450	1.0356
10	1.1022	1.0960	1.0850
15	1.1522	1.1460	1.1346
20	1.2004	1.1920	1.1801
25	1.2483	1.2407	1.2291

8. The open-tank treatment with zinc chloride consists of a hot bath followed by a cooling treatment, in which atmospheric pressure alone is used to obtain results that are quickly accomplished by artificial pressure in the closed cylinder process of other methods. The solution is heated in the open tank to 190° to 200° F. Higher temperatures, as has been stated, cause warping, and the quick formation of insoluble zinc rosinates, etc., which hinder exudation from the wood cells and prevent thorough impregnation. Different temperatures should be tried with different woods to determine the maxium which will not cause warping.

The hot treatment should last fully 3 hours and be followed by immersion in a cold solution for 1 hour during which time the wood cells contract and retain the impregnated solution. If not economical or practical to use a second cold bath, the wood should remain in pickle over night, so that the original solution will be thoroughly cooled. The attendants ("picklers") should be specially cautioned against immersing dry timber in a cold zinc chloride solution. The oxychlorides of zinc which form in a cold solution are inert as a germicide or preservative. Experiments indicate that the degree of impregnation of pine timbers of the same degree of dryness can be regulated by varying the temperature of the cooling bath.

9. To secure the maximum effective penetration, the wood must be thoroughly seasoned before treatment with zinc chloride. Seasoned timbers have been treated very effectively by the open-tank process, but green timbers only fairly so. Four years after the treatment of seasoned timbers no decay was found, while 13 per cent. of green timbers similarly treated showed signs of decay. The open-tank process is best suited to the treatment of cypress, unseasoned or partly unseasoned loblolly and Pennsylvania pines, and of seasoned Western pines. Before treatment, all timber should be cut and framed to final form and dimensions, as sawing, cutting, and boring are likely to expose the untreated wood to attack by destroying organisms. Timber should be wholly immersed throughout the treatment and thereafter should be dried where completely shielded from the sun.

Table 6

Solution Per Cent.	Specific Gravity of Solution (Cold)	Solution Per Cent.	Specific Gravity of Solution (Cold)
5	1.045	35	1.352
10	1.091	40	1.420
15	1.137	45	1.488
20	1.187	50	1.566
25	1.238	55	1.650
30	1.291	60	1.740

10. The open tank may be an old boiler shell or a rectangular tank equipped with steam coils or with a hearth beneath. A derrick or gin pole with tackle is needed for handling heavy timbers.

A steel tank, 3 ft. × 3 ft. × 33 ft. of ¼-inch plates, capacity 1,500 gallons, is used at the United States Boat Yard at St. Louis, Mo. The tank is heated by four lengths of 1½-inch steam pipe laid inside along the bottom. A thermometer is installed at each end. The total cost of the tank was only $275.

11. The variables entering into the open-tank process, subject to future and more extended investigations are:

(*a*) Duration and times of immersion in hot and cold bath.

(*b*) Temperature of hot bath.

(*c*) Strength of solution required for each kind of wood.

(*d*) The degree of impregnation probable for each kind of wood.

Table 7 shows the absorption of poles cooled over night, for timber cut at different periods of the year.

12. The method of open-tank treatment is preferred for the following reasons:

(*a*) The elimination of steam, vacuum, and pressure features of the cylinder process, and of the expensive machinery necessary.

(*b*) The light and economical construction of the tank.

(*c*) The cost for maintenance is much less than for any other process.

(*d*) The small amount of labor required.

(*e*) In general, the low cost of tank treatment is well within reach of most boat builders, mine operators, and engineering concerns requiring small plants.

13. In the use of zinc chloride for wood preservation it has been found that

(*a*) The solution is non-poisonous in handling.

(*b*) Impregnated wood may be worked with tools, the same as ordinary wood.

(*c*) The treatment does not discolor wood, and it will take varnish and paint.

(*d*) It is completely immune to "dry rot."

(*e*) Timber so treated is suitable for furniture, buildings, paving, and general railway purposes, interior work of boat building, but must not be used in submerged work, as running water is liable to leach out the preservative salts.

(*f*) Too strong a solution of zinc chloride or aluminum sulphate makes the wood brashy, brittle, and blue in color.

14. A 4-per-cent. solution, containing some scrap zinc to prevent oxidation of the contained salts is suggested for the strength of the initial solution. The specific gravity of a 4-per-cent. solution is 1.037, and as 1 gallon of water at 62.50° F. weighs 8.33 pounds, the number of gallons of water per 100 pounds of zinc chloride may be estimated as follows:

$$\frac{100}{1.037 \times 8.33 \times .04} = 300 \text{ gals. nearly}$$

15. The absorption after a hot bath of 2 or 3 hours followed by cooling for 24 hours is about 18 pounds per cubic foot. Seasoned timber in cold solution alone has absorbed 12 pounds per cubic foot. In general, Western pines absorb 16 to 18 pounds of 3-per-cent. solution per cubic foot, and 12 to 14 pounds of 4-per-cent. solution. Chloride of zinc costs 4 to 5 cents per pound (1914) and with an impregnation of .3 to .5 pound of this salt per cubic foot of timber or 25 pounds to 40 pounds per 1,000 feet B. M., the cost of treatment by the open-tank process, including labor, will be $2 to $3 per 1,000 feet B. M.

The following method of determining zinc chloride in samples of timber has been found very satisfactory not only locally, but by many tie treating plants and railroads. Three grams of dry borings should be weighed into a 250-cubic-centimeter flask and 3 cubic centimeters of concentrated sulphuric acid added. The flask should be gently heated on a sand bath or hot plate until the wood becomes thoroughly charred. A few drops of concentrated nitric acid should then be added; when brown fumes have disappeared, a few more drops should be added, and the addition continued, a few drops at a time (toward the last the amount should be increased) until the organic matter is destroyed. When this point is reached, the liquid will remain colorless on further heating. The flask should then be allowed to cool and the contents diluted with 100 cubic centimeters of water (added carefully at first). As a rule, the residue in the flask will be completely dissolved, but if there should be a slight sediment it may be disregarded. Ammonium hydroxide should be added until distinctly alkaline and allowed to cool. If there is a precipitate of iron hydroxide or if there is any dissolved sediment in the flask, it should be filtered; if not, it should be poured into a 400-cubic-centimeter beaker, 5 cubic centimeters of ammonium sulphide added and allowed to stand over night. It should be then filtered into an 11-cubic meter filter paper, washed thoroughly with water containing ammonium sulphide and dried. It should then be incinerated in a porcelain crucible, and roasted until the zinc chloride is converted into zinc oxide. The weight should be divided by 3 and the result multiplied by 1.674, which will give the number of grams of zinc chloride contained in 1 gram of the wood, or the number of pounds per pound of wood. To convert this result into pounds of zinc chloride per cubic

Table 7

Time of Cutting	Weight Per Cubic Foot Before Treating	Poles Averaged	Duration of Treatment		Average Absorption Per Pole
			Hot Bath	Cooling	
	Pounds	Pounds	Hours	Hours	Pounds
Spring	22½	8	5	Overnight	61.5
Winter	24	20	6	Overnight	62.0
Summer	28	90	4-7	Overnight	45.0

foot of wood, multiply by the weight in pounds of 1 cubic foot of the wood.

The Freezing Point of Low Freezing Explosives

*By Arthur LaMotte, Editor**

We are frequently asked, "What is the actual freezing point of Red Cross dynamite and Du Pont gelatine dynamite?" The "straight unvarnished truth" is "we do not know," but few will believe that when we tell them.

If you asked an ordinarily well-educated man, "What is the freezing point of water?" he would say promptly "32° F." But if you asked a very learned physicist the same question he would probably qualify his answer by saying that it depended on several things, the nature of the container, the pressure, and whether the liquid was moving or absolutely still. If water is kept absolutely quiet, its temperature may be lowered to 14° F. without its freezing (Kent). In a glass tube ¼ inch diameter it freezes at 23° F. In a glass tube 1/200 inch in diameter it freezes at from 3° F. to 4° F. (Trautwine).

Water is one of the simplest of chemical compounds, while the dynamites, especially the low freezing ones, are exceedingly complex, both chemically and physically, since they contain various nitrated compounds, finely ground inorganic nitrates and carbonaceous ingredients.

Chemically pure nitroglycerine under normal conditions will freeze at about 55° F. However, the actual freezing temperature of the ordinary high freezing dynamites and gelatines may be considerably lower.

The theoretical freezing point of ordinary sweet glycerine is about 62° F. yet it is used in anti-freezing mixtures for automobiles and gas meters. In the coldest weather a drum of frozen glycerine is considered rather a curiosity at the dynamite works where thousands of drums of glycerine are stored all winter in the open.

Freezing points, then, are not as simple and fixed temperatures as they seem. Even a very simple substance may freeze at very different temperatures under different conditions.

The temperatures at which Red Cross dynamites and Du Pont Gelatine dynamites freeze vary in a similar manner, and therefore no definite figure can be given as their freezing temperature. However, they have been known to remain unfrozen when exposed to a temperature below zero for a week. On the other hand, instances have been known where these powders have frozen at temperatures higher than 40° F. The low freezing qualities of these explosives is evidenced by the fact that very few instances of powder being frozen in the field have been encountered.

They freeze much easier and quicker if they have once been frozen and then thawed, as in the second winter storage.

From the foregoing you will see how unfair it is to insist on our naming or guaranteeing a specific freezing point, for it cannot honestly be done by this company or any manufacturer of low freezing explosives, but we can say that our low freezing explosives represent the best in that respect that science has so far produced, and bear the Du Pont guarantee as to quality.

**Du Pont Magazine.*

Aczoling Timber

This describes the preservation of timber by aczol, which is a mixture of metallic ammoniates with an antiseptic acid containing phenols and naphthalenes, the essential preservative elements of creosote. The compound is claimed to have especially great and enduring preservative value. Owing to the solubility of cellulose and vaculose in aczol, the surface layers of the fibers and tissues of the wood treated are coated and cemented together by a combined chemical and physical action which yields secondary and perfectly stable compounds. As sold, aczol contains 15 to 30 per cent. of reinforced phenols and the equivalent of 30 per cent. of copper and zinc salts. This concentrated material is estimated to have 150 times the preservative power actually required to effect sterilization. Hence, and because the preservative elements are fixed permanently in the aczol-cellulose compounds, a very dilute solution may be used. Timber to be buried or exposed continuously to weather may be painted with a one in five or six solution of aczol in water. Impregnation is preferable and must be employed for telegraph poles. Injection is by simple immersion for two or three weeks, or more rapidly by pressure; cold solution is used. The weight of the timber is hardly increased by treatment; the wood is not rendered objectionable nor dangerous in any way, but is appreciably strengthened, and it can be painted or polished after treatment. By regulating the strength of solution used, timber can be made waterproof or flameproof. None of the ingredients of aczol corrodes iron or other metals, nor do they reduce the insulating value of wood.—*Electric Review*, Vol. 74, p. 85.

Formation of Coke

An important paper has been read by S. W. Parr and H. L. Olin (Bulletin 60, University Illinois Engineering Experiment Station) on "The Coking of Coal at Low Temperature." Experiments were carried out by the authors which confirm the following theoretical conditions namely, that (1) for the formation of coke there must be present certain bodies which have a rather definite melting point; (2) the temperature at which decomposition takes place must be above the melting point; (3) where the compounds that satisfy the first and second conditions are unsaturated, it is possible by subjecting them to oxidation, so to lower the temperature of decomposition as to alter the second condition prescribed, in which case coking will not occur.

Hillcrest, Alberta, Explosion

A Description of the Mine, the Ventilation, and General Conditions as Shown by the Commissioner's Report of the Investigation

Written for The Colliery Engineer

THE coal mine of the Hillcrest Coal and Coke Co., Alberta, is on the eastern flank of the Rocky Mountains in the southwestern part of Alberta. It is on a spur of the Crows Nest Pass branch of the Canadian Pacific Railroad, 2 miles southeast of Frank. The coal bearing measures in this Blairmore-Frank coal field, have been placed by the Canadian Geological Survey in the Belly River Series of the middle and lower Cretaceous formation, which here approximates 740 feet in thickness, has seven seams of coal each over 8 feet, six seams of coal between 5 feet and 8 feet each, and eight seams under 5 feet each.

The coal measures have been greatly disturbed by faulting and folding, consequently the seams vary in position from the horizontal to the vertical and in one instance "the coal bed is being worked in slightly overturned strata."

A sample of the Hillcrest "run-of-mine" coal had the following proximate analysis:

Fixed carbon, 55.4; volatile matter, 29.3; ash, 14.6. The moisture was 14.6 per cent. and the sulphur .6 per cent. in the analysis; as fired, the moisture in the coal was but .8 per cent. and the heat units obtained amounted to 12,360.

The coal as a rule is of good quality, although somewhat high in ash.

According to reports the thickness of the Hillcrest seam varies from 12 feet to 20 feet, dips 30 degrees west and is worked through a rock tunnel and slopes.

From the end of the rock tunnel, which is 400 feet long, No. 1 slope is driven, and from this slope levels branch off. No. 2 slope is separate and 2,500 feet long. The system of mining followed is room and pillar, compressed-air machines being used inside the mine. Underground haulage is by horses to the mouth of the tunnel, where the cars are made into trains and hauled 3,000 feet to the tipple by a small locomotive. Here the coal is dumped and lowered 240 feet by rope and button retarding conveyer to coal pockets from which it is loaded into railroad cars. The capacity of the mine is about 1,400 tons daily.

According to the evidence taken by Judge A. A. Carpenter, who was appointed commissioner to inquire into the cause of the disaster by the Provincial Government of Canada, the explosion took place about 9:30 A. M., June 19, 1914. At the time of the explosion there were 235 employes of the company in the mines. Of these, 189 perished, the only ones saved being in No. 1 north level, where the effect of the explosion was but slightly felt. No naked lights were allowed in the mine, Wolf safety lamps being adopted, and each lamp was examined by two examiners. It is against the Mines Act for men to take matches, pipes, or tobacco, into a mine of this kind, but that a search was made to ascertain whether or not the men had matches, etc., was not brought out by the evidence. The rock formation in this mine is the same as the Bellevue, where 4 years ago a number of explosions occurred which were attributed to sparks emitted by falls of rock. Two witnesses claim they had seen a fall of rock strike fire in the old workings of this mine, but there was no conclusive evidence that this was the cause or that a miner's tool struck fire and set off the gas. There were three electric pumps in No. 2 slope, placed, respectively, 130 feet, 900 feet, and 1,500 feet down the slope. The report of the electrician shows the feed-cables were properly insulated and with the system of ventilation in vogue there was no suggestion that the explosion originated in No. 2 slope, and that cause of ignition was eliminated. Exact detail of the ventilation of the mines was known only to the mine manager, Mr. Quigley, and the overman, Mr. Taylor, and both of these men were victims of the explosion.

Under the provisions of the Alberta Mines Act the mine operators are not required to keep in their office a plan of the ventilation system of the mine. Consequently the only evidence that was available in this regard was that of the surviving Examiners.

Of the two entrances to the Hillcrest mine one is called the Rock Tunnel leading to No. 1 slope, and the other is called No. 2 slope. All coal from the workings east and south of No. 1 slope is taken up through the Rock tunnel, and this part of the mine is called No. 1 mine; while the coal from all the other portions of the mine is taken up No. 2 slope and this for convenience is referred to as No. 2 mine. No. 1 and No. 2 mine are connected so that in reality they form one mine.

The ventilation of the mine was induced by one electrically driven Sirocco fan placed a little south of the Rock tunnel, which acted as an exhaust fan and had a capacity of 100,000 cubic feet of air per minute, while a little north of the No. 2 slope there was a steam driven fan used to force air into No. 1 north level. The return air from No. 1 north level, apparently, joined the intake air going down No. 2 slope, the combined currents moving to No. 2 south level, along this level to the face, returning along the working faces of No. 2 south to room 31, and thence to the exhaust fan through an overcast over the new slope after ventilating the working places of No. 1 south level. Another air-current passed down No. 1 slope, returning along the counter after having ventilated the places in the level off this slope, and the places above the slope where the pillars

were being extracted. The air-current going through the Rock tunnel was split at the junction of this tunnel with No. 1 slope and the new slope, one portion traveling down the new slope as far as a stopping at about the second breakthrough in room 31. That this current did not play any important part in the ventilation of the mine may be judged by the fact that no measurement apparently was ever taken of the air passing down the new slope. The evidence was that a certain amount of this current leaked through this stopping into room 31 and joined the air-current ventilating the workings of No. 1 south level. The workings below No. 2 slope, as far down as No. 3 south level, appear to have been ventilated by a split from No. 2 slope, but below No. 3 south level the workings were ventilated by means of compressed air.

The turning of the return air-current from No. 1 north level into the intake current going down No. 2 mine was criticised by Mr. Fraser and others, as it meant turning vitiated air into fresh air used to ventilate another part of the mine. There was an overcast crossing No. 2 slope above the junction of this slope and No. 1 south level, and had the return air from No. 1 north level been carried through this overcast to the surface no objection to this part of the ventilation could be raised. The evidence was, however, that this overcast at the time of the accident was not being used, and that the return current from No. 1 north level did travel down No. 2 slope and mingle with the fresh air supplied to No. 2 mine. The air traveling through the mine was measured on the 16th of June by the overman, 3 days prior to the accident, and his record shows that 14,500 cubic feet of air per minute were forced into the workings of No. 1 north level; 24,000 cubic feet were being taken down No. 2 slope, and 54,600 cubic feet were being drawn down No. 1 slope. Mr. Fraser, the miners' expert witness, seemed to think that in taking the volume of air coming down No. 2 slope at 24,000 cubic feet the overman included the return air from No. 1 north level. To accept this would imply that the dead overman was guilty of a species of fraud and the Commissioner could not find anything to warrant the adoption of such a view.

It was apparent from the measurements that there was a sufficient quantity of air passing through the mine to insure proper ventilation provided the air was pure and properly distributed.

Mr. Fraser took the view that the term "ventilation district" in the Alberta law was used in the same sense as in the British Coal Mines Act, and as to No. 2 mine he suggested that No. 1 north level and No. 2 south level were both on the same split. On the other hand, Mr. Drinnan, the company's expert, was inclined to give a much wider interpretation to the term, and in his opinion No. 1 north level and No. 2 south level were two distinct splits. Mr. Brown, the company's manager, was of much the same opinion, and the Commissioner stated that if the return current from No. 1 north level had traveled through the overcast over No. 2 slope, there would be no possible doubt but that there were two distinct districts or splits in No. 2 mine.

Assuming that there were two distinct splits in No. 2 mine, it still seems that there were more than the 70 men, as authorized by law, employed in each district of these workings. The reports of the company do not give very distinct information as to the number of men employed in the various parts of the mine. The explanation given was that the men, with the exception of the miners, are often moved from one part of the mine to another. The estimate of Mr. Fraser as to the number of men employed in No. 2 mine, exclusive of No. 1 north level, in view of the evidence, was in the Commissioner's opinion excessive. It is impossible to fix exactly the number of men employed in No. 2 mine at the time of the disaster. Rescue parties, as may be readily conceived, paid little attention to the location where the bodies of the victims were found, and even the location of the bodies could not be conclusive in this regard. There is little doubt that many of the men, after the explosion, left their working places in an attempt to escape before they succumbed to the effect of the afterdamp.

According to the figures submitted by the company showing the number of men checked into the mine on the morning of the disaster, there were 59 in No. 1 mine and 176 in No. 2 mine. All of the men in No. 1 north level, 46 in number, were saved, so that the remaining portion of No. 2 mine shows that there were 130 men. The evidence, however, bears out the company's explanation that the men were moved about the mine. While the figures show that there were three trackmen in No. 2 mine and none in No. 1 mine, the evidence shows that one of these men was killed in No. 1 mine. Again, while there is no positive evidence on the point, it appears that the number of buckers found in No. 1 mine was very considerably greater than the company's figures show. The Commissioner thinks an extreme estimate of the men employed in No. 2 mine, apart from No. 1 north level, to be 120 and was possibly less. Assuming that there were 120 there at the time of the disaster, it will be seen that the quantity of air coming down No. 2 slope would be at least sufficient to allow the required 200 cubic feet per man that is required by the Act.

In regard to sending the return air from No. 1 north level down No. 2 slope, the weight of evidence goes to show that the system of ventilation, while apparently not dangerous in this mine, is open to severe criticism. While this is so, there is nothing to show that the system contributed any to the cause of the explosion. Neither can it be stated that the use of compressed air in the workings of No. 2 slope below No. 3 south level is accountable in any way for the disaster. It is practi-

cally admitted that the explosion did not originate in this portion of the mine.

Although the system of ventilation was open to criticism, there seems to be but one opinion in regard to the ventilation as far as the men of the mine were concerned, and that was that the ventilation was good in their particular working places. The month before the disaster, the conditions were not so good. Evidence was given that traveling caps, that is the existence of such an amount of gas in the ventilating current as would show a flame in a test with a safety lamp, were found, but this condition was remedied by driving through room 31. Since that time and up to the time of the disaster, there had been no complaints on the part of the men. A report of the miners' pit committee, made on the 18th of May, just one month before the disaster, stated that they found the ventilation good. The question of gas in the mine must be intimately connected with the question of ventilation. At the same time, the presence of gas is not necessarily an indication of an inefficient system of ventilation. An accumulation of gas may arise from the fact that the brattices have not been carried sufficiently near the faces of the workings and consequently the air-current is not conducted near enough the faces to carry away the gas. In a mine of this nature, there is generally more or less gas. In any mine where inflammable gas has been found within 3 months, an inspection of the roadways leading through the mine and the working places must, under the provisions of the Alberta Mines Act, be made within 3 hours before each shift goes to work.

During this inspection, a test is made for gas and the examiner makes a report as to the condition of the mine, such report being recorded in a book kept for that purpose and a copy of this report is posted immediately in a conspicuous place at the mine. The last inspection of this nature made before the explosion was by Examiner William Adlam, who went into the mine about 10 minutes to four, and came out at 20 minutes past six in the morning that the disaster occurred. His report showed presence of gas in rooms 2, 5, 12, 17, 7, 8, and 43. Rooms 2, 12, and 17 are on No. 1 north level, rooms 7 and 8 are on No. 3 south level, and rooms 4 and 43 are on No. 2 south level. It is a custom of the brattice men who attend to the placing of the brattices so as to conduct the air-current up to the working faces and so clear those places of gas, to go into the mine a half hour or so before the shifts go in. The examiners on duty at that hour give the brattice men the orders posted upon the report of the examiner who has made the inspection. The lamps of the brattice men are examined by the examiners, and in this case John Ironmonger swears that he examined the lamps of the brattice men when they went into the mines.

According to the examiner's statements, it is evident that in the raise in No. 1 north level and the raise in No. 2 south level, there was considerable gas and it does seem that it would have been advisable that these places should have been cleared before the miners entered the mines. Such a course, at least, would have avoided an element of danger that had to exist if the raises were being cleared after the miners had gone to work. Mr. Hudson, representative of the Dominion Department of Mines, expressed his opinion that nothing indicated an undue amount of gas at that time. The theory of Mr. Fraser was that the explosion originated in the workings of No. 2 south level. If such were the case, except so far as it would tend to vitiate the air-current going through No. 2 south, the gas in all the working places but 5 and 43 may be eliminated so far as this phase of the investigation is concerned. The mine had been idle on the 17th and 18th of June, the two days immediately before the day of the disaster, but the ventilation system with the exception of the working of hand fans, was in full operation and a perusal of the mine examiner's report for those days shows the mines to have been more than ordinarily free from gas during that time. There does not seem to be anything in the evidence in regard to the presence of gas in the mine that assists in leading the Commissioner to any conclusion as to the cause of the disaster nor to lead to his condemnation of the general system of ventilation in use in the mine. In regard to the character of the dust in the Hillcrest mine, both counsel for the mine owners and the miners at the inquiry agreed that he should avail himself of the results of the test made by the United States Bureau of Mines as to the explosibility of samples of dust taken from the Hillcrest mine. Without adopting any technical language, it may be said that these tests show that the dust in this mine is of fairly highly explosive character and the dust would ignite by a blown-out shot or by an ignited pocket of gas.

Mr. Aspinall, who was government inspector of mines for this district a year or two prior to the disaster, said that he considered the mine a dusty one. On the other hand, the evidence of nearly all of the men working in the mine was to the effect that prior to the explosion they would not consider this a dusty mine. With the exception of No. 1 slope, the main roadways were more or less wet. The Commissioner does not think that the evidence was such as to show that the company had any reason to believe there was a dangerous quantity of dust in the mine.

In concluding his report, Commissioner Carpenter says: "Apart from the matters I have already dealt in, there does not appear to be anything in connection with the management of the mine nor in the care taken by the company in its operations that could have led or contributed in any way to the disaster. The initial cause of the explosion does not seem to be ascertainable. The coroner's jury recommended that the employes be searched at stated intervals for matches, pipes, and tobacco."

The Tripp Shaft Disaster

Peculiar Accident Causing the Death of 13 Men—Explosion Wrecks Cage but the Shaft is Unscathed

By W. Z. Price

Dynamite still maintains its reputation as a freak explosive. On Wednesday, December 9, at 6:20 A. M., while 14 men were descending the Tripp shaft, an explosion of dynamite occurred on the cage. The bottom of the cage dropped away and 13 of the men fell to the shaft bottom over 300 feet below.

The Tripp shaft is part of the Diamond colliery of the Delaware, Lackawanna & Western Coal Co., at Scranton, Pa. It is 499 feet in depth, cutting in order the Rock, Clark, and the three Dunmore seams.

On the morning of the explosion, one of the men, John Pasley, received 25 pounds of dynamite. He got on the cage with the other 13 men and when they were about 184 feet below the surface, between the Rock and Clark seams, an explosion took place. The 3-inch planks on the floor of the cage were broken and hurled to the bottom of the shaft. The truss rods at one side of the cage snapped at the points *C* and *D* (Fig. 1), forcing the weight on that side to be borne by the 4″ × 10″ white oak upright. The force, however, was so great that the upright broke at *A–B*. It gives the appearance of a tensile break, the wood being torn. This caused the entire weight on the floor of the cage to be supported by the truss rods and the upright on the opposite side. The leverage was so great that the upright on that side snapped off flush with the floor. This allowed the floor to hang down, it being held to the top of the cage simply by the truss rods on that side. This, of course, precipitated the men to the bottom of the shaft.

The head-man, James Gallagher, was ill, and Joseph Merrick, who was acting in that capacity that morning, counted but ten men getting on the cage. It is believed the others surreptitiously got on from the opposite end. The one man who escaped, Martin Bolinski, owing to a natural fear of descending a shaft, was holding to an arm that supports the bonnet on the side of the cage least affected. He held fast until the Clark seam was reached, where the cage stopped and he clambered to safety.

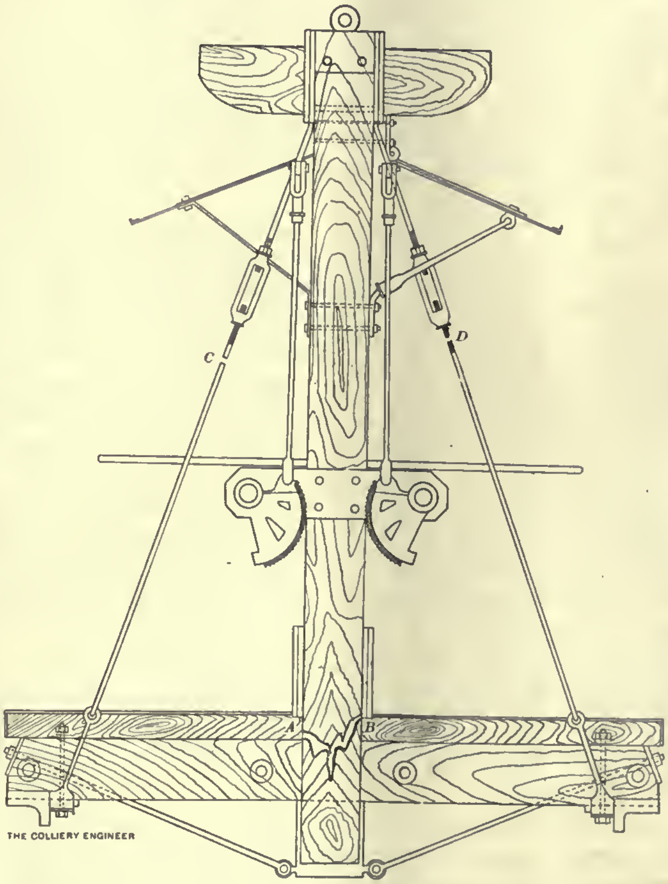

Fig. 1. Elevation of Cage, Showing Breaks

Bolinski has made several contradictory statements, and at this writing has not appeared as a witness so that he could be examined under oath. He either was so excited that he has no clear idea of what happened, or he is dodging the question. He is quoted as having said there was an explosion, that there was a loud roar, and also that he heard no explosion. The evidence of several witnesses who testified they heard a report and experienced the fumes of dynamite, indicates that Bolinski's statement that he heard the report of an explosion is the truth.

The shaft timbering, cage and rope, were in good condition, having been examined that same morning, as is the daily custom. In this respect the company exceeds the law's requirements for safety, by having two men inspect both hoistways, going up and down inspecting the timbers and guides.

When the explosion occurred the cage in the other hoistway was over 60 feet below that on which the men were riding, and yet part of the box and an unexploded piece of dynamite were found on it. One piece was picked up near the shaft in the Clark seam, 30 feet below. Eight or ten sticks fell to the bottom of the shaft without exploding. The timbering and sides of the shaft were unscathed by the explosion. It is probable that it will never be known just what detonated the dynamite.

Col. R. A. Phillips, general manager of the company, has issued the following statement:

"No one more deeply regrets the terrible accident than I do. The Lackawanna company is spending many thousands of dollars annually in the "Safety-First" movement to insure protection to the lives and limbs of employes, and the rules and regulations of the company are as

strict and as comprehensive as human intelligence can make them.

"We find that John Pasley, a miner, was taking a box of dynamite into his chamber. He was one of the victims. So far as we have ascertained, and, I believe our investigation has been thorough, none of the other men on the cage with Mr. Pasley had any dynamite, unless they carried a few sticks in their pockets. The box Mr. Pasley carried contained about 25 pounds of dynamite.

"The Diamond shaft is approximately 500 feet deep, and the Clark vein about 200 feet from the surface. As near as we can learn, the explosion occurred about 15 feet above the Clark vein, as the cage was being lowered with the men on it.

"Of the occupants of the cage, Martin Bolinski is the only survivor, and he has been unable to throw very much light on the accident. He said he heard something go 'puff' with a loud noise and the next thing he knew the bottom fell out of the cage. He had been holding on to one of the side rods and that saved him, but he probably also had some footing.

"The floor of the cage was not blown down the shaft. The explosion broke the supports at one side, and the floor dropped down like the leaf of a table. The damage to the cage was not substantial. It will take but a few hours for two or three carpenters to repair it. There was no damage done to the timbering in the shaft or to the guides on which the cage on which the men were, is run, or to the other cage, or the ropes, or any other part of the equipment. The unfortunate part of it is that it was so disastrous to life.

"That thirteen men are dead and one man survived, establishes the fact that there must have been fourteen men on the cage, or else four of the victims were blown off the other cage by the force of the explosion. But, our investigation shows that there were no men on the other cage; consequently, the fourteen were on the one where the explosion occurred.

"It is the law of the state that not more than ten persons shall be permitted to ride up or down a mine at the same time; and the Lackawanna company has supplemented the law of the state by issuing strict orders to all head-men and foot-men not to let more than ten up or down at one time.

"How the dynamite happened to explode I do not know, and presume shall not be able ever to know, as all the occupants of the carriage, but one, are dead, and that one can throw no light on it. All he knows, he said, is he heard an explosion of dynamite and instantly the floor gave away.

"As the cage was about midway in the shaft at the time, it is probable that all the thirteen would have been killed by the fall of nearly 300 feet if they were not already dead from the explosion; but their bodies were not mutilated as might be expected from the explosion of such a quantity of dynamite in such close proximity to them. The sump is 4 or 5 feet deep and their bodies were piled up there in a heap. Some eight or ten sticks of dynamite were found here and there along the buntons in the shaft or beside the bodies in the sump. Why they also did not go off I do not know unless they may have been frozen too much.

"As far as miners carrying dynamite in with them on their way to work, my impression is that it is safer than placing it in a car. A man knows the dangerous character of dynamite and is careful to handle it with the greatest care. Whether the box fell from Mr. Pasley's hands, or whether he was shifting it from one shoulder to another, as it is frequently carried, and it accidentally dropped, of course I can only conjecture."

The number of freak explosions that have occurred in the past few years corroborate the belief that dynamite is most peculiar in its action. Several years ago at the South Wilkes-Barre colliery, of the Lehigh & Wilkes-Barre Coal Co., a man dropped a box of dynamite from his shoulder to the ground. It exploded, killing him and four others. At another time, while stacking boxes of dynamite in a powder house, one slipped from the hands of the man handling it, and fell 10 feet to the concrete floor. The box burst open, the sticks scattering in many directions, but there was no explosion.

Several years ago a railroad car loaded with dynamite broke away from a train and ran at terrific speed down the Ashley plane, near Wilkes-Barre, Pa. Near the foot of the plane it was derailed and collided with other cars on the siding, resulting in a terrific explosion. It was found afterward that only about half of the dynamite in the car exploded, the remainder being intact.

It must have been an explosion similar to the last case mentioned that occurred in the Tripp shaft. All the dynamite was in one box and a number of sticks were found at the bottom of the shaft, only a part of those in the box having exploded. It is doubtful whether the action of dynamite in case of accident can ever be accurately foretold.

Our Front Cover

The illustration on our front cover shows the coal storage plant which protects the city of New York from interruption of its electric lighting service from 136th Street to the Battery.

The plant illustrated is at Shady Side, N. J., about opposite 110th Street, Manhattan, and has a capacity of 156,000 tons of coal. A detailed illustrated description of this plant will appear in our February issue.

The Tyrone Division of the Pennsylvania Railroad, the coal coming from Clearfield and neighboring regions, is short 600,000 tons this year as compared with the tonnage of last year. This indicates the state of business.

WITH THE EDITORS

Efficiency

MERE hustle and bustle do not mean efficiency. A man may "mark time" like a 2-minute trotting horse and yet get nowhere. Some men seem to think that if they just work hard enough they must succeed—that working hard means efficiency. They are the ones who accept the maxim that "diligence is the mother of good luck."

But what works more diligently than a boat's propeller when racing out of water—or than an engine when the belt slips and the load is off?

We do not think that a man is born efficient. He may be born tired—but not efficient.

Of course there may be a natural adaptability for acquiring methods that make for efficiency, and there are certain natural qualities that raise the grade of efficiency; but most largely efficiency is a matter of training—of education.

There are several definitions of efficiency. One is accomplishing the most useful results at the least expenditure of energy.

Another is, doing a thing accurately and thoroughly.

Another is trustworthiness. Doing the thing we are assigned to do, and doing it thoroughly.

We believe any man of fair intelligence can be trained to be efficient—trained even to be trustworthy.

The above epigrams were made by Prof. C. J. Norwood and delivered at a recent meeting of the Kentucky Mining Institute. Each one is an editorial in itself and should be committed to memory not only by employes but by employers.

The Hillcrest Explosion

ON ANOTHER page will be found an abstract from the Commissioner's report on the Hillcrest, Alberta, mine explosion, which occurred June 19, 1914. The report is by Judge A. A. Carpenter, a lawyer of prominence, and it is interesting even although it leaves out those things which might have caused the disaster and puts in those things which did not cause the explosion and there is no advice given us that we may avoid similar accidents.

We once held the opinion that English mining men, while slower, arrived at more definite conclusions regarding mine explosions than did the mining fraternity of the United States. We are obliged now in view of the recent reports issued on several explosions that have occurred in the British Empire to reverse our opinion and say that the commissioners arrived at the place they started from, namely, nowhere. As we look at the matter in this country, the chief reason for the investigations of mine explosions is to ascertain their cause and, so soon as possible, to give the exact or the probable reason for their happening. To accomplish this, inspectors and engineers enter the mine so soon as ventilation is restored, and even before in some cases, in order to note the position, condition, and location of the bodies, also to ascertain whether the men were burned or were killed by afterdamp; also other matters that would have a tendency to point toward the probable cause of the disaster are carefully noted. The greatest force is not as a rule shown where the gas is ignited, particularly if dust is a factor, so that by following the clues left by the explosion, it is possible to arrive at the place where the disaster originated, and then by signs or analogy arrive at a fairly definite conclusion. It is taken for granted that no one desired an explosion; and if negligence was the cause, the coroner's jury after listening to those who explored the mine places the blame where it belongs. It is only by acting in an impartial way that the facts can be made public quickly, and so prevent possible accidents from similar causes.

Our English brethren, out of respect for the commissioners examining into the cause, give out no particulars of importance for publication until the report has been printed, which in this case was several months after the explosion and it then furnished no definite information. These remarks are made not with the idea of criticizing but in the hope of benefiting the industry in Canada as well as in the United States.

The Pennsylvania mine law demands that maps of bituminous mines shall show the plan of ventilation, and about every mine map in this country has the ventilation marked on it, so that the mining engineer and the manager, or, in fact, even strangers entering the mine shortly after the explosion, can follow the ventilation from the blueprints or tracings of the mine map which they carry.

In the Hillcrest mine, Wolf safety lamps were used, which under ordinary conditions go out in a gaseous atmosphere. Undoubtedly, unusual conditions could prevail where gas might be ignited by Wolf lamps. For instance, an unlighted lamp might be knocked over and having a loose wick, oil might run on the glass or gauze, and then on being picked up and lighted, the burning oil might break the glass, or if on the gauze, flash the flame outside. Mr. Frazer, who represented the miners at the Hillcrest inquest, condemned the practice of turning vitiated air from one section of a mine into a fresh air-

current that circulated in another part of the mine.* In this he was right even although as it is claimed the explosion did not occur in this part of the mine. A peculiar feature in connection with this system of ventilation is that while an overcast was constructed to receive the return air from this part of the mine it was not used.* It is well understood that a little bit added to another little bit makes just a little bit more, and a ribbon of gas lighted in this second part of the mine might have flashed to that part where the gas had formed an explosive mixture. In No. 2 south level, a boy was engaged in forcing air up a pitch and it was in this level that Mr. Frazer thinks the trouble originated. We can imagine that a boy after turning a hand fan for 2 hours might want a rest and then on starting the fan again force the gas down on the level, but there are not enough data available to affirm or deny Mr. Frazer's contention. However, we do know that these things have happened in the anthracite fields of Pennsylvania and we do know that fans and air boxes are not the best means of ventilating the pitching rooms which are difficult to clear of gas.*

We might speculate on other matters such as the powder used, whether it was customary to blast while men were in the mine, also on the probabilities of roof falling and creating sparks which ignited the gas, and after all be none the wiser, because the position of the bodies and their condition, with other valuable data were not noted. There is always a cause for an explosion and it can be reached generally quite closely by analogy, providing one does not start with preconceived ideas. It is of great importance to the operators and inspectors of Alberta to arrive at some kind of a conclusion whenever they have an explosion, because their deductions will always be on the side of safety and be of general use to the industry at large.

*See the new Alberta law which went into effect December 1, 1914.

Educating the Miner

THE small percentage of ambitious miners who in the past 20 years have recognized the importance of a mining education have as a rule taken courses in correspondence schools. Some of these men have been promoted to high official positions by their employers; others have obtained official positions through their preparedness; and still others of them have obtained positions as State Mine Inspectors because of their qualifications.

Recognizing the value of these courses, mine managers of some large coal corporations are encouraging students by furnishing them rooms in which to study and engineers to assist them. It is probable that the success of correspondence students has been the chief reason for the educational wave now sweeping over the various coal mining fields, for the successful student advises his friends to study.

Although sporadic attempts have been made locally for many years to educate the miner and his boys, it is only within the last 5 years that the movement has been general in its scope. In a measure this has been due to individual effort in the various coal mining towns and villages.

Some operators after having fitted up club rooms where the men could meet socially in the evening, afterwards arranged with the local school teacher, the company mining engineer, or possibly a local member of the Y. M. C. A., to teach a night school, at their mine. In the anthracite fields large mining institutes have been formed, and the vocational schools have a large attendance at night.

In Illinois, Kentucky, Pennsylvania, and West Virginia, what are known as University Extension Schools have been organized for the purpose of carrying education to the miners and their sons. Much of this endeavor has been with a view to increasing the efficiency of the men, to lessening the number of accidents in mines, and making more intelligent men who will be able to cope with the changing conditions that are making coal mines each succeeding year more difficult to work, such as more common use of machinery, greater depth, and larger production.

Many of the foreign-born miners are unable to speak English, and Dr. Peter Roberts has devised a simple means of teaching them. Colonel Phillips, of the D., L. & W. Coal Co., has had printed and illustrated a book showing the right and wrong method of working in mines, with the view of decreasing accidents.

In West Virginia, Miss Marguerite W. Jordan is teaching domestic science to the women in the mining towns, and Miss Mary Quick, a nurse, is teaching hygiene.

There are other plans inaugurated for the purpose of creating ambition and satisfaction among mine workers. In some camps prizes are given to those who keep the houses and yards neat, also to those who cultivate gardens. For sanitary purposes, bath houses and swimming pools have been installed; for the children and young men, playgrounds and athletic fields are equipped and sports encouraged.

The miner of today is in far better shape to make headway and enjoy the pleasures of life than his predecessor of 20 years ago, and if he will believe that his employer wants him to prosper, as most employers do, he will have gained still more contentment and enjoyment in life.

The present movement for the education of miners exists all over the United States and is not confined to the Eastern states. The Colorado School of Mines at Golden, Colo., and the Mackay School of Mines at Reno, Nev., both have short courses during the month of February, 1915, for prospectors and ore miners. Washington and Idaho Universities have similar courses some time during the winter when prospecting is impossible.

Mining Institute Meetings

Winter Meetings of the Illinois Coal Mining Institute, the Coal Mining Institute of America, and the Kentucky Mining Institute

Written for The Colliery Engineer

THE second annual session of the Illinois Mining Institute was held at Springfield, November 19, and when the meeting was called to order, representatives from all over the state were present. John S. Schnepp, mayor of Springfield, welcomed the members, and the exercises were commenced by President Thomas Moses calling on W. C. Adams, electrical engineer with the Allen & Garcia Co., of Chicago.

Mr. Adams' paper was on the "Electrification of a Coal Mine," and in it he advised the use of electricity wherever it was possible in or about a mine. Owing to steam line condensation, radiation, conduction, etc., the inefficiency of steam engines, he stated, was directly proportional to the length of the line.

Steam engines, he declared, were undesirable motors for fan driving on account of the difficulty of keeping the fan in operation when changing the packing, etc.; besides, when the piston packing does not fit tightly in the cylinders, the engine will use from 90 to 100 pounds of steam per indicated horsepower.

In the anthracite fields, long lines of steam pipe are covered and exposed to the weather both summer and winter, but after tests had been made it has been found that the loss in scrapping the installation and the cost of a new installation, divided by the comparative losses of the two systems, does not warrant change, although at new plants there are advantages to be derived from electrical installations. The steam-engine-driven fan is still preferred by many to the motor-driven fan, and if the disadvantages named by Mr. Adams are to be accepted as applying to fans, they must apply equally to the engine that generates the power, and then the motor driving the fan must stop while repairs are made. Electricity has been the cause of many improvements in coal mining, such as undercutting, hauling, pumping, lighting, and preparing the coal for market. It is comparatively easy to carry into the mine, and the transportation of the power is not affected by temperature changes. Electric locomotives are a decided improvement over other means of haulage underground and on the surface, in fact electric haulage equipment is not only economical in power but offers advantages in efficient work, convenience, and safety, which cannot be reckoned altogether in dollars and cents.

In regard to the prevention of accidents from electricity in and about mines, Mr. Adams prepared rules similar to those issued by Robert Quin, manager of the Susquehanna Coal Co., Wilkes-Barre, and the United States Coal and Coke Co., Gary, W. Va.

1. All wires should be insulated wherever possible. This is in contrast with some who believe that bare wires will be more respected than covered wires.
2. All bare wires are to be guarded.
3. All wires should be put up carefully and should not touch doors, props, etc.
4. It should be impressed upon the men that all wires are dangerous.
5. The wiring should be carefully calculated and properly put up, otherwise excessive line losses will result and the consequent low voltage will mean motor troubles and expense.
6. To insure careful power distribution where feeders are employed, the system must be complete, so that if the service in one part of the mine is interrupted, the rest will not be affected.
7. Conductors down shafts, bore holes, etc., should be insulated and in some cases armored.

The author of the paper pointed out the importance of having an independent line to the fan and that the speed of the motor for driving the fan should be adjustable.

Emergency switches should be placed at convenient points about tipples and breakers where the machinery is electric driven, so that the speed can be cut down or the machine stopped in case of emergency. He also emphasized that local conditions should be carefully studied before the voltage is decided on, because the future possibilities of the mine as well as the present needs must be considered, also the number of cars that can be handled at the shaft bottom in a given time and the distribution of the cars as well as the distance and the grades they must be hauled. He made it a point that equal service for each entry and each room should be planned. As the tractive effort is the fundamental in mine hauling, he would reduce friction as much as possible by roller bearings; and for computing the weight of the rails to be used he makes use of the following rule: Make the rail weight 10 pounds per yard for each 1,500 pounds weight on each driver.

When it comes to electric hoists, he would use a flywheel motor generator, as the input and output of power is not identical throughout any fixed time, but the flywheel naturally serves to store energy and return it when needed to more nearly equalize the distribution. Maximum efficiency is accomplished only when the power is being consumed at the same rate as it is being furnished. In providing a drum for the hoist, he advises the use of a cylindrical drum when the rope speed is low.

Patrick Hogan, state mine inspector, from Canton, Ill., read a paper outlining his reasons for believing that the panel system of mining was superior to the old method of room-and-pillar mining. Next to longwall working, he considers the panel

system is the most proficient from a ventilation point of view. Another advantage he claimed for it was that abandoned panels may be sealed, and the power wasted in ventilating old workings conserved. If a fire were to start in a panel, it is possible to smother it so that only that portion of the workings will be stopped. Haulage roads, he stated, can be kept in better condition, and the concentration of the work accomplished.

In the discussion that followed, President Moses said that there was far greater recovery with the panel system than with any other save longwall. He mentioned the gas entries that are driven in many cases in mines of the H. C. Frick Coke Co., in western Pennsylvania, which are for the purpose of draining the gas from old panels. John P. Reese, general superintendent of the Superior Coal Co., did not believe that haulage was any cheaper with the panel system than in the room-and-pillar system, on account of the motor having to go long distances between panels for but one or two rooms working on new entries. He said the nature of the roof, the surface ownership and its cost were vital points that must be considered, as it is a common thing for land once worth $25 an acre to be valued at $200 when injured by a mine below, as every property owner considers he has a perfect right to rob a corporation. Mr. Reese insisted that squeezes often help farms owing to the surface movement which permits the moisture to sink deeper into the ground and which also shakes up the subsoil. He knew of one instance in southern Illinois where a squeeze caused a depression of an acre and a half which gave rise to a good pond in that dry district, yet the company had to pay the farmer $250 and let him keep the land.

The advantage of the electric cap lamps was next taken up by Mr. R. M. Gambol, of the Hirsch Electric Lamp Co. He explained the working principles of the Hirsch lamp, stated the United States Bureau of Mines requirements for a good lamp, and showed how they were complied with by his company. He told of the use of electric lamps in the rescue work at the Mulga, Ala., explosion and at the Royalton, Ill., explosion.

The next business of the day was the election of institute officers for 1915. H. W. Stark was elected president, W. H. Burton and F. S. Pfahler, vice-presidents, Martin Bolt, secretary-treasurer, and Messrs. John Bohlander, J. S. Reid, J. P. Reese, John Dunlop, and Patrick Hogan were elected as executive committee.

Three claimants for damages aggregating $24,000 took advantage of the attendance at the institute of John P. Reese, superintendent of the Superior Coal Co.'s mines at Gillespie, to serve him with notice of suits against the company in the Illinois Circuit Court. The suits could have been instituted in Macoupin County, where the mines are located and where Mr. Reese always can be found.

Mr. Thomas Moses, the retiring president of the Institute and general superintendent of the Bunsen Coal Co., invited the institute to hold its May, 1915, meeting in Danville, Ill., and the invitation was unanimously accepted.

Coal Mining Institute of America

The Coal Mining Institute of America held its annual winter meeting in Pittsburg, December 8-9. The program was carried through from start to finish without a hitch, which is somewhat unusual at meetings of this kind. Jesse K. Johnston, president of the Institute, presided and was reelected for the ensuing year.

William Seddon was elected first vice-president; Joseph Williams, second vice-president; and Dr. W. R. Crane, third vice-president. The executive board elected was composed of W. E. Fohl, Pittsburg; George E. Gay, Uniontown; and C. L. Clark, New Alexandria. Mr. Charles L. Fay tried to resign but the members refused his request, so that he continues as secretary-treasurer with headquarters at Wilkes-Barre.

President Johnston's address was good, and while he was deploring the small attendance, the room filled to overflowing, about 160 showing they were not that kind of member. President Johnston's speech we hope to print in due time.

William Seddon read his discussion on the "Applicability of the Longwall System of Mining to the Pittsburg Seam." Mr. S. A. Taylor did not favor it. Mr. Leo Gluck explained how longwall advancing worked in Spring Valley Coal Co.'s mine in Illinois. Another practical man wanted to know if it had ever been tried in Pennsylvania and being an adept in mining, he did not believe it would be successful, besides he failed to see the necessity for its introduction. His remarks were based on the changes that had been introduced in western Pennsylvania to mine this seam. At first one-half the coal was mined on the advance and a large proportion of pillar coal was lost. Next, one-third of the coal was mined on the advance, and not so large a percentage of pillar coal lost. More recently the panel system was introduced so that one-fifth is mined on the advance and the four-fifths left in the pillars is recovered by machines on the second mining.

Mr. Lewis made a few remarks on his experience with longwall advancing when in Vancouver, B. C., and he seemed satisfied with the system followed in mining the Pittsburg bed in Pennsylvania. From the opinions expressed, it is probable that the panel system will be continued until some concern with plenty of money attempts the use of the longwall retreating method in Pennsylvania.

In the discussion on "The Safe Voltage for Use in Coal Mines," Mr. Jenks thought that a high voltage was safer than a low voltage because men had more respect for it. That a low voltage required a considerable larger quantity of current to do the work, and therefore larger

conductors. That more danger resulted from poor insulation and weak hangers than from the voltage. Mr. Jenks qualified these statements and it is believed that a low voltage is the best for coal mines, but insulation is a good thing as a power saver as well as safeguard against accidents.

Prof. E. N. Zern, of the University of West Virginia, read a paper on "Do Compensation Laws Increase or Decrease Accidents?" It was so comprehensive that it is given in full elsewhere.

In the discussion on the "Advantages and Disadvantages of Portable Electric Lamps," Messrs. Deike and Hospital seemed to have reached the conclusion that electric lamps were superior safety accessories in coal mines.

In the evening the Institute dinner was made enjoyable by Dr. H. M. Chance, of Philadelphia, Mr. F. L. Lewis, of Columbus, Ohio, and Professor Young, of Kansas. All three made admirable speeches which gave those in attendance a new insight into affairs that affect the public. Mr. Lewis addressed the members on "Government Control With Relation to the Coal Mining Industry."

Doctor Chance's address was on the same subject, but from a different angle.

Professor Young addressed the members on the experimental work being carried on to purify the water used in Pittsburg, which is made acid through factories, mills, metallurgical works, and mines.

Dr. E. W. Parker, of the United States Geological Survey, read a paper on the "Foreign Coal Trade of the United States." He stated that while there was an excellent opportunity of disposing of coal in Europe and elsewhere, it would be only the high-grade coal.

"Germany," he said, "has rather pursued the not unwise conservative policy of using her fuel at home and exporting to other countries the manufactured products which bear the familiar legend, 'Made in Germany.'

"Great Britain's profligacy with her coal supply has had much to do with making her the greatest maritime country of the world and the greatest carrier of ocean-borne freight, but she is now beginning to feel the pinch of poverty in connection with her coal supplies, and it would not be surprising if, when the present war is over, Great Britain should limit her export trade to the needs of naval vessels and bunker trade.

"To what other countries then than to the United States are those countries, in themselves partly or entirely barren of coal, to look for their fuel supplies? It does not appear that the United States has any reason to fear a shortage of fuel for many years to come, some centuries, in fact, but there are some economic questions to be considered. England has an advantage for export in coal from the proximity of her coal fields to the seaboard, in some cases the coal being loaded directly from the mines into the vessels.

"All of the coals of the United States which are available for export are some distance inland, and rail or water hauls, with transshipment to vessels at seaboard, are necessary. This condition is somewhat counterbalanced by the fact that, although wages among the British miners are lower than in this country, the total cost of mining in the United States is lower owing to more favorable conditions and to the large extent to which mining machines have replaced the more expensive hand labor. Probably our prices at the seaboard for Clearfield, Cumberland, New River, Pocahontas, or Alabama coals do not exceed those of English coals of comparative quality.

"Naturally, during the continuance of the war, there will be an increasing demand for American coal, probably as much of a demand as we find vessels in which to send it, for at no time in our history has the paucity of American vessels been so forcibly thrust upon us as at the present juncture. If Great Britain should cease to export coal it is probable that a good portion of the trade that goes to southern Europe might come to the United States.

"I cannot say that I am altogether in sympathy with the idea of sending our best coal to supply the needs of foreign consumers, but my personal predilection has nothing to do with the case. If the producers of American coal want that foreign trade, let them go to it, and if this outlet helps to take care of our excessive capacity and results in some better returns to the coal operators for the energy and capital that they have put into the business, few there are who are familiar with the coal mining business that will object. Doubtless by the time our supplies of high-grade coals are growing low, the world's dependance upon coal will be less than it is at the present day."

An interesting discussion followed the reading of Mr. Parker's paper in which the larger part of the members participated.

Mr. E. M. Chance, of Wilkes-Barre, made some remarks on briquetting small anthracite, in which he stated that the culm banks as a rule carried too much ash to make first-class briquets; besides, that when the price of pitch, the manufacturing cost of material, and the transportation, were included, they made the cost prohibitive.

Mr. R. D. Hall read an interesting paper on the "Last Stand of the Mine Roof." In this paper Mr. Hall attempts to explain that roof thrusts could not exist if the roof was a true beam or plate. He made use of the arching of mine roofs as an explanation for localized strain and unequal balance of stress, the causes of horizontal shear and the reasons for ultimate collapse. "An arch is a structure where the stresses due to the weight combine with horizontal thrusts so that support is secured without bending-moment strain. In fact an arch cannot exist so long as a structure is so constituted that its bending moment strains are adequate to the support of the load." The paper was commented on favorably.

"Personal Observations in Alaska," was the subject of an interesting talk by Dr. W. R. Crane, of State College. Toward the close of his lecture he gave many laughable extracts from his experiences which were of human interest, and his audience greatly enjoyed his stories from real life, which he seemed happy to work out of his system, although several were embarrassing to him at the time of their occurrence.

The two-day session was closed by Mr. L. M. Jones, mining engineer, of the Bureau of Mines, reading a paper on "Coal-Dust Experiments at Experimental Mine, Bruceton, Pa."

From the secretary-treasurer's report, the Institute has a large number of members who fail to pay their dues. This makes times hard for the Institute and prevents the publication of the papers presented. Last year the deficit was met in a measure by subscribing members, and unless dues are paid something similar must be repeated. Some members are in arrears for 4 years, others 3, and very many for 2 years. This Institute is a valuable asset to the mining industry of Pennsylvania and should be ahead rather than behind in funds.

Kentucky Mining Institute Meeting

The business sessions and banquet of the winter meeting of the Kentucky Mining Institute were held in Louisville, on December 4 and 5, 1914.

Heretofore the sessions have been held in Lexington, but in the future it is the intention of holding one meeting each year in some other town in the state. The coal industry of Kentucky is divided into eastern and western fields, one being in the great Appalachian coal field and the other in the Eastern Central coal field, which includes Indiana, Illinois, and western Kentucky. The two fields are separated so far as now known by the "Cincinnati uplift," however, the state of Kentucky has not been thoroughly prospected and its coal geology studied, owing to lack of appropriations for the work. What has been accomplished geologically and in the prospecting line in this state can be credited to private enterprise, and to Mr. Hutchcraft, of Lexington.

Kentucky has many thousand acres of undeveloped coal lands, both in the east and west, some of which has railroad facilities. The 1913 output of Kentucky was 19,400,000 tons, making it the fifth state in point of coal production of the United States. The Kentucky Mining Institute is composed of mining men from both ends of the state, and of the 60 members present the eastern and western fields were about equally represented.

About forty members attended the banquet, the remainder preferring to attend the theater. Fifteen new members were admitted to the Institute, which now numbers 250. Friday afternoon the delegates were given an address of welcome by the Hon. John Buschmeyer, Mayor of Louisville. Friday evening Frank H. Cassell, president of the Merchants and Manufacturers Association, addressed the members and said: "If you see anything you want in Louisville, just take it." Mr. J. W. Paul, of the Bureau of Mines, read an interesting paper in which he reviewed the work done by the Bureau in rescue and first aid. Mr. J. T. Beard, of New York, editor of the *Mine Inspectors' Institute*, gave a very interesting address on "State Mine Laws," in which he pointed to their lack of uniformity, method of printing, and that in cases they are not even indexed. He also criticized the examination questions and the methods of holding examinations for mine inspectors, mine foremen, and fire bosses. He advocated the use of books of reference in these examinations, while others believe that all the formulas in creation are useless if the applicant for a certificate is unable to tell how the mine should be ventilated and furnish the proper quantity of air per man. In some states catch questions are propounded, and in other states questions that were impossible to answer. Mr. Beard's remarks could not be discussed by the members of the Institute because they were more applicable to other states.

C. J. Norwood, Dean of the College of Mines and Metallurgy, State University of Kentucky, also the Dean of Coal Mining in the State of Kentucky, read a paper on "The Need of Better Education of Miners and What the College of Mines and Metallurgy is Doing in Their Behalf."

Miss Marguerite Jordan's paper, which appears in another column, was read at the banquet by Mr. Frank Rash, of the St. Bernard Coal Co., of Earlington. Some interesting remarks were made on this paper, pro and con, by Mr. Wright and by Mr. Philo Dix, state secretary of the Kentucky Y. M. C. A.

It is gratifying to note that the women of Kentucky are forcing war on illiteracy. Mrs. Gilmer S. Adams, of Louisville, has a society for the purpose and invites aid and cooperation. Almost while Mr. Rash was reading Miss Jordan's paper in behalf of the miners, Mrs. Cora Wilson Stewart spoke at Winchester in behalf of the campaign in Clark County for the eradication of adult illiteracy in Kentucky. Mrs. Stewart outlined plans for the work of teaching "moonlight schools" and called for volunteer teachers. It is to be hoped that other states, from Maine to Georgia, will join in this movement and give native Americans the same opportunties as the Americans give the imported element.

Professor Norwood stated that Kentucky had increased its coal output 9,128,000 tons in 5 years, and its number of underground workers from 14,958 to 25,000 in the same period of time. In speaking of the attitude of the public toward miners, he said: "If a great dam breaks, a great flood occurs, a factory fire happens, or a bridge gives way, and a large number of lives are lost, the public considers it an act of Providence; but if an accident occurs in a mine but one interpretation is

given, viz., it was the fault of the mine officials. A mine is a mystery to the general public which receives its news from a very inaccurate and oftentimes sensational newspaper. An explosion once occurred in Kentucky in which 5 men were killed, but the newspapers reported 66 killed."

He quoted the *North American* of Philadelphia as follows:

"Mauch Chunk, Pa.—Willis Shafer, son of George Bertine Shafer, who was killed by a lightning bolt on Monday and who had crawled a mile to Nesquehoning to tell what happened, is somewhat improved. There are indications that both he and George Yost, who were struck by the same bolt, will recover."

An excellent Kentucky newspaper after commenting on the reduction in the fatality rate among coal mines last year, stated: "The danger to those who go down in mines is almost as great as to those who go down to sea. It is an awful life that the poor fellows lead and the cause of humanity demands that their condition in life be made as bearable as possible. Shut out from the light of heaven and often working lying flat on the back with the ever-present possibility of the rock roof caving in and crushing them to death, it has always been a wonder to us how the number of miners should be maintained. It is probably explainable only on the hypothesis that the poor fellows are bound to do something for a living and take the risk as a dernier resort."

Men with reputations that will light safety matches are the ones who misinform the public on mining matters and we might include them with miners as being in need of broader education. Among the things to teach is the danger from powder smoke and that "Safety First" is to be considered every time before output.

The *Saturday Evening Post* not long ago stated: "Nearly half the people who die in Indiana between the ages of 15 and 35 die of preventable diseases." A similar state of affairs is true of mining accidents where even more than half are preventable; however, unless mine workers are educated not only to recognize how they may be prevented, but to observe the rules at the base of prevention, mine accidents will continue, and more than half of them will find no excuse in the natural hazard of the mine."

The College of Mines and Metallurgy in Kentucky has three courses:

1. A 4-year course for training young men in mining engineering.
2. A 2-year course for young and middle-aged men who for any reason are unable to take the 4-year course.
3. An 8-week course for adult practical miners

Mr. Norwood believes, however, that state mining schools can do their greatest work in educating miners by carrying the work right to the mines by means of extension schools, and this he proposes to do so soon as he receives the necessary backing.

K. U. Maguire, president of the Harlan Coal Mining Co., Coxton, Ky., read a paper on "What Kentucky Operators May Expect of the Workmen's Compensation Law."

Note.—This law was declared unconstitutional on December 12, 1914. —Editor.

W. H. Cunningham, consulting engineer, of Ashland, Ky., who has worked hard in the formulation of a compensation law and who is also secretary of the Kentucky Coal Operators' Association, gave an interesting address which we hope to print when the stenographer's notes are transcribed. Mr. Cunningham, in order to make amends for not writing his speech, wrote the following:

"Who'll buy a hopper bottom
Filled with coal and not with cotton?
Who'll spend a dollar for a ton?
Buy a car of coal,
Warm your bones and cheer your soul
And bring good times coming on the run."

Mr. J. W. Reed, Assistant Inspector of Mines in Kentucky, read a paper on "Humidifying Mine Air as Practiced in Eastern Kentucky."

White L. Moss, vice-president Continental Coal Corporation, Pineville, Ky., acted as toastmaster at the banquet, and from the way he faked telegrams one would think that next to the European war this Institute meeting occupied the attention of the Administration, in fact halted the judicial functions of the state and nation.

H. La Viers, president of the Institute, made a pleasing address, in which he told of the present condition of the Institute and his expectations for its future. Those members who were not afraid of the rain went to Indiana to visit the Speed Cement Works, and in the evening the theaters absorbed the delegates.

F. V. Ruckman, general manager Highland Mining Co., Providence, Ky., read a paper on "Mining in Western Kentucky." He said that while coal mining has disadvantages in most every field, it usually has some advantages. In western Kentucky the coal measures had a fairly uniform dip, giving a practically level floor adapted to mine haulage. This being so, there were mules, electric motors, gasoline locomotives, and rope haulage systems.

The two beds worked, No. 9 and No. 11, are regular in height and fairly uniform in quality throughout the field. The average thickness of No. 9 bed (Illinois No. 5) is 5 feet. No. 11 (Illinois No. 6) bed is more irregular and where worked is 6 feet and over. The No. 12 seam is being developed to some extent in Webster, Hopkins, McLean, and Muhlenberg counties. This is good coal that varies from 4 feet to 6 feet in thickness.

The existence of faults is rare and they are seldom encountered in their mildest form in the western Kentucky field.

A paper on "The Opportunities and Obligations Abroad for America's Coal Trade," by George H. Cushing, editor of the *Black Dia-*

mond, was interesting, but arrived at the same conclusion expressed by the tramp when he said: "If I had some ham and some eggs I would have some ham and eggs," or as the darkey said: "If you want possum stew you must first catch de possum."

The meeting was a success and from the number of groups found talking in most every corner of the hotel, there was no time wasted.

Humidifying Mine Air

In Eastern Kentucky—Methods That Have Proved Efficient for Keeping the Mine Moist and Avoiding Fog

*By Joseph W. Reed**

THERE are a number of methods of dealing with the dry dusty conditions that appear in mines during the winter. Humidifying of the intake air is conceded by most to be the best way to deal with this condition. Personally, I feel that it is the only method which insures even comparative safety. Proper humidification of the air not only moistens the dust on the ribs and roof, but also moistens the dust particles floating in the air, causing them to become heavy and fall to the bottom.

Observations taken over a period of several years show that in the eastern section of Kentucky there is a deficiency of moisture in the intake air for practically 7 months of the year. With normal weather, artificial means of supplying this deficiency are needed from November 1 to May 1. During the dry periods preceding November and following May, the mine will normally take care of itself, unless surrounded by exceptionally dry strata. From the observations taken, it was found that the amount of water necessary to properly humidify the air varied from 2 to 4 gallons per 100,000 cubic feet of air, 2 gallons during early fall and late spring, and 4 gallons during mid-winter. This amount varies greatly on individual days, but it was found that the mine could be used to some extent as a storehouse, and moisture stored up on warm days to supply the exceptionally dry or cold days following, provided the extreme cold or dry days did not continue for more than a week at a time. Do not make the mistake, which is common, of looking on warm days and moist days as being the same. It is true that cold days are dry days except on those rare occasions when the cold is accompanied by a dense fog, but warm weather closely following cold weather is ordinarily just as dry as the cold weather. For this reason humidifying is necessary during March, April, and sometimes a portion of May.

Steam was adopted as the easiest method of placing the moisture in the air, and boiler plants were installed at each mine for this purpose. As no work other than that of boiling water was to be put on the boilers, old boilers condemned for high pressure were used, they being much cheaper and just as satisfactory as new boilers. One hundred horsepower return tubular boilers were used. These are about 5 feet in diameter and 16 to 18 feet long. They were set in a standard boiler setting with a light wood building as a protection from the weather. Only a short stack is used as it is not intended to fire them heavily and not much draft is needed.

The steam is carried direct into the fanway by a 2-inch pipe line and a branch is carried into each airway. These branch lines are only carried beyond the crop-affected roof near the outcrop.

I should state here that this company uses only blowing fans, having found them more satisfactory for all kinds and classes of mines operated by it. These fans have a reversible fan setting for use in case of emergency. The ventilation is laid out with the intention of using steam, and the air travels from 1,500 to 2,000 feet before reaching entries where men are required regularly to work. The steam is turned into the air near the bottom and in the center of the airway. It quickly rises to the roof and spreads out till it fills the entire airway with a dense white fog. A small amount condenses and settles to the bottom as a fine mist of rain, but this loss is only a small percentage. By having a large sectional area in the airway, the air travels at a low velocity. After traveling about 2,000 feet, it is heated by the surrounding strata to near the mine temperature. As the temperature rises the moisture or fog gradually is absorbed by the air which remains constantly at 100 per cent. relative humidity, until the fog is absorbed.

This absorption of moisture is due to the increase in the temperature. This function of air should perhaps be mentioned here; namely, that air has a greater capacity for moisture as the temperature increases. Thus 100,000 cubic feet of air at 40° F. will be fully saturated by (or could normally contain) but 1 gallon of water, while at 60° F., or the average mine temperature, it will absorb or could contain 10 gallons of water. The fact that makes the use of steam practical is that a large quantity of water in the form of fog may be carried in the air at any temperature, much the same as mud is carried by a river. Thus the air at 4 degrees and a capacity to absorb 1 gallon of water permits the other 9 gallons to be carried along as fog and gradually absorbs the moisture necessary as it is warmed by its passage through the mine. The best results are obtained when the amount of steam is so regulated that the fog disappears at the point where the air reaches the normal mine temperature. This point varies with the temperature of the intake air and with the velocity of the air in the airways. I have found it, under conditions ordinarily met

*Paper read at the Louisville meeting of the Kentucky Mining Institute.

with in coal mines, to be from 1,500 feet to 2,000 feet from the intake. This distance makes this method of using steam impractical in the new mine during its first stages of development, due to fogging up the entries and working places of the miners. If steam is to be used in such a mine, a mine-air heater should be used with the steam. This shortens the distance the fog travels into the mine. In the mines of which I have been speaking, steam was not used in the development stage. The dry conditions were taken care of by watering with a sprinkler, which, though not entirely satisfactory, was undoubtedly of considerable value. Also, as the workings were not extensive at this stage, the amount of sprinkling and labor necessary to keep the mine in a moist condition was not difficult to provide.

After installing the steam plants at the mine, it becomes necessary to fire them in such manner as to put the proper amount of water into the air. They started in the fall with 2 gallons per minute, or 2,880 gallons per day for a mine using 100,000 cubic feet of air. Making allowance for loss of moisture, this becomes about 2½ barrels of water per hour. In the boiler used, one barrel is approximately 1 inch on the water gauge. It is thus only necessary for the fireman to so regulate his fire that the water is lowered 2½ inches on the gauge each hour. This should theoretically put the fog line at its proper place in the mine, but, as in all things relating to a mine, it needs some individual attention. This is given it by the mine foreman. The foreman keeps track of the fog line inside, and should it penetrate far enough to make working conditions dangerous on the entries, he notifies the boiler tender to this effect and has the quantity of water boiled per hour reduced until conditions are satisfactory in the mine.

I must state that I have found that the fogging up of the entries was more generally due to poor brattice work and leaks along the main airways than to the use of too much steam. In a few instances it was due to the use of too large a quantity of air, which caused the temperature of the air to remain considerably below that of the normal mine.

In this work advantage is taken of the fact that it is easier to boil water at a low pressure than a high pressure, and the valve leading to the mine is left wide open, thus requiring only enough pressure to force the steam into the mine. This varies from 1 to 5 pounds. The water supply pipe of the boiler was connected to that used for fire protection and from which sufficient pressure is obtainable to force the water into the boiler by simply opening the valve, thus doing away with the use of an injector, and making the firing of the boiler so simple that any man around the mine can do it easily.

In the mines in which this system was in use last winter, only a small amount of drying out occurred. It

The Marchers

Written for The Colliery Engineer by R. T. Strohm

There's a flutter of Old Glory down the middle of the street,
There's the hollow, muffled beating of a drum,
There's a distant blare of brasses and a steady tramp of feet,
And a swift, excited whisper, "Here they come!"
Then they pass in swaying columns, with no sign of halt or pause,
Human brothers of the rabbit and the mole,
And the air is filled with shouting and the echo of applause
For the husky, stalwart diggers of the coal.

They are not exactly frisky, and they don't display the pep
That the military man is apt to show;
They are careless in their marching, and they fail to keep in step,
And the lines that should be straight are sure to bow;
At the rounding of a corner they will straggle as they swing,
In a manner that the crowds consider droll;
Still, in spite of such maneuvers, they become the real thing
When they turn from drilling men to drilling coal.

Though their numbers make an army, yet no uniforms they boast,
And the multitude in motley garb is dressed;
Golden lace and polished trappings shed no glory on the host,
And they wear no iron crosses on the breast.
Neither show nor ostentation is affected by the bunch,
Each is satisfied to play an humble role;
But beneath their calm and quiet they conceal the mighty punch
That is needed by the men who dig the coal.

They have never fought with rifles, but they know the powder's smell,
For they've done a deal of shootiug in their day;
They have never faced the cannon's mouth nor heard the shrieking shell,
But they've challenged death in quite as brave a way;
And the gnarled and battered fingers, and the twisted, crooked limb,
And the bluish marks that freckle cheek and jowl
Are the honored scars of conflict, won in chambers deep and dim,
In the never-ending battle for the coal.

was found in practice necessary to reduce the distance the fog traveled in the air to a point where the air had not yet reached its full mine temperature. Thus, not the full amount of moisture was supplied, yet it was found that the natural production of water by the mine was sufficient to provide most of this extra moisture and that the mine remained damp, drops of moisture standing out on the roof and ribs and the condition known as sweating was maintained both summer and winter over most of the mine. The portions of the mine that were affected by slight drying were remedied by occasionally at night increasing the amount of steam until the entire mine was filled with fog, sufficient of which was precipitated to moisten those dry portions.

At some of the mines only a small temporary boiler was installed last winter. At these mines it was found that though not enough steam was supplied to keep the entire mine moist, yet even a small amount of steam greatly reduced the extent of the dry sections and made watering by sprinkler or water car considerably more effective and lasting.

A great deal in this work depends on the amount of judgment shown by the foreman, as he must keep closely in touch with the beginning of dry conditions, in fact, must anticipate them and must also prevent the causing of unpleasant working conditions and fogging of the haulways by too much steam. In a very large mine, this can be taken care of mostly by theory, but in the ordinary mine the theoretical amount must frequently be tempered by the use of good judgment. At all times it is essential that the foreman give attention to keeping the brattices in air-tight condition and so regulate his ventilation as not to have too high a velocity of air in the main airways.

With an honest effort by the foreman to accept the theory and apply it with ordinary judgment, working as close to it as the conditions of the mine will allow, very good results were always obtained.

OBITUARY

JOHN C. HADDOCK

John C. Haddock, one of the most prominent of the independent operators of the Pennsylvania anthracite field, died in New York City on December 20, aged 64 years.

Mr. Haddock was a native of County Longsford, Ireland, and, when an infant, was brought to this country by his parents, who located in Lenox, Mass. At an early age he began work as an errand boy for a commercial house in Newport, R. I., at a wage of $2 per week. He left this lowly position for a clerkship in a wholesale grocery house, which position he occupied for 1 year. He then had a chance to connect himself with the wholesale and retail coal business which he accepted. In 1871, when just 21 years of age, he was sent to Fall River, Mass., to take charge of a coal business in that town. Three years later he became manager of the wholesale coal business of Meeker & Dean in New York City.

In 1877 he went into the coal mining business by leasing the Dodson mine, at Plymouth, Pa., which was supposed at that time to be practically worked out. In company with Messrs. Eno and Shonk, who were the original lessors, he formed the Plymouth Coal Co. In 1883 he bought the interests of his partners. A year before this, with Charles S. Steel as a partner, he took over the lease of the Black Diamond mine, at Luzerne, Pa., and later consolidated the two operations under one company. His judgment in securing the so-called worked-out Dodson mine made him a rich man. He sunk the shaft deeper to the Baltimore seam, and drove a tunnel to the Five-Foot seam, lying about 100 feet above the Baltimore. These improvements resulted in the development of a mine producing 800 tons per day, as against 300 tons, its old record.

Mr. Haddock had a most pleasing personality but like the late Eckley B. Coxe he objected to what he considered imposition, and in 1890 started an agitation for the regulation of the supply of coal cars. Not receiving satisfaction from railway officials he began to publicly agitate against railroad discrimination, using the argument that not only individual operators but their workingmen were being subjected to hardships. This fight led by Mr. Haddock, and in which other individual operators joined, resulted in laws being enacted governing the matters of coal transportation and the distribution of cars.

In all his disputes and litigations with railroad managements, Mr. Haddock always held the respect of his opponents, and at no time did his business disputes result in any permanent ill feeling between him and his antagonists, or interfere with their personal friendship.

He was always considerate of his employes, and through his efforts the Plymouth Coal Co. established a tax on its coal production to create a benefit fund for them.

His attitude toward the mine workers in the 1902 strike strengthened the belief of the miners that he was interested in their welfare.

Relative Dangers

Mine disasters are given prominent display in the newspapers, and this has given rise to the erroneous impression that mining is the most dangerous of all occupations. A recent study of the casualty record of the coal mines, railroads, and steel mills in this country, revealed that mining was the least dangerous occupation of the three. In 1911, the latest year for which there are official figures in the three industries, 31,334 of the 729,279 coal miners were injured; 126,039 of the 1,669,809 railroad employes; and 35,764 of the 158,604 steel employes. A reduction of these figures to a common basis brings out the fact that for each thousand men employed 225.48 were hurt in the steel mills, 75.48 on the railroads, and 42.96 in the coal mines.

Manufacture of Steel Pipe

Description of the Process by which this Important Article of Mine Use is Made, Beginning at the Ore

Written for The Colliery Engineer

One of the entertainments for the members of the American Institute of Mining Engineers at the Pittsburg meeting was a trip to the McKeesport plant of the National Tube Co. The special trolley car that left the Hotel Schenley shortly after lunch, carried the visitors up hill and down hill, crossed the river to Homestead, and continued until it found another river to cross and finally reached the McKeesport plant. This ride alone was worth the money.

Iron Furnace

Welding Furnace

On reaching the works the visitors were met by the manager and a corps of assistants, who led them to a place where a cradle dump turned railroad cars filled with Lake Superior iron ore upside down until the iron ore spilled in a hole from which it could be removed and stacked by a scraper line, or by a large grab bucket that raised and carried it where stacking was most convenient. Owing to the Great Lakes freezing, water transportation is not possible in winter, for which reason the large steel companies are obliged to buy their ore during the summer and stack a sufficient supply to keep them running during at least 130 days when navigation is closed. As the four furnaces at this plant are capable of making 800 tons of pig iron daily, and as it takes 1.66 tons ore for 1 ton of pig iron, 172,640 tons of ore are required to tide them over the period of no shipments; but transportation is subject to derangement the same as a Ford, and the wise furnace manager keeps at least 14 days supply of ore on hand over and above his actual needs, so that McKeesport furnaces have, estimating roughly, 200,000 tons of ore in stock, a matter which means possibly $900,000. We did not ask the cost of unloading the ore but estimated it was about 7 cents per ton when stacked. On being escorted to the furnaces we looked in a tuyere (twir) through blue glass and saw a continuous stream of molten iron and slag trickling down into the hearth, and then saw the slag run from the furnace to the pit, where, coming in contact with a stream of water, it was granulated into pumice-stone-like material about 3/8 inch in size. This was lifted from the pit by locomotive cranes, with clam-shell bucket attachment, and deposited on cars which the P. R. R. hauls gratis as it makes cheap ballast and filling.

Casting Ingots

The guides next moved us toward the converter stands, where the molten pig iron is conveyed from a 300-ton mixer to large pear-shaped vessels into which it is poured and converted into steel by blowing air through the metal and decarbonizing it. The slag from the converters has considerable graphite associated with it and this floats about when the slag cars are dumped. From the converters, the large ingot molds, which we saw filled from the converters, were allowed to cool until the steel reached the proper temperature where the mold could be lifted or skinned from the ingot. The ingots were reheated in a cooking pit and rolled into billets, and these in turn were broken down into sizes that would correspond to the thickness and width of the skelp or flat sheets of steel desired.

Among the interesting sights was a machine which could be adjusted to cut red hot skelp to any length automatically. This machine, called the "flying shear," invented by one of the employes, saves the labor of 8 men and does much faster work. After being cut in proper lengths and carried by rollers to the end of the run, the skelp is lifted on a bench and transferred by endless chain laterally to a car which takes it to the bending furnace. Lap-welded tubes are made from these flat strips of soft steel (or skelp) after their edges have been properly dressed. The skelp is next placed in the bending furnace raised to annealing heat (redness) and the skelp drawn from the front of the furnace through a die which forms it into circular shape with the edges overlapping. The rough tube is then raised to a welding heat in a regenerative furnace, and when the proper temperature, 1,750° F., is obtained, it is passed through an opening in the front of the furnace into the welding rolls. Between these rolls a mandrel is held in position inside the tube and the edges of the rough tube are welded between the mandrel and the rolls. The tube then enters the sizing rolls to make the inside and outside diameters uniform and finally passes through the straightening rolls, after which each piece of pipe is rolled by machinery upon a cooling table where, when sufficiently cool, it is cut to lengths by saws and is then ready for inspection. Each piece of pipe made in the National Tube Co.'s mills is inspected for surface defects and all boiler tubes and certain lap-welded tubes for special purposes are given physical tests in machines that combine a flattening, crushing-down and flange test in one. The pipe is not finished until it has been threaded and tested by means of hydraulic pressure.

The guides led the party from the tube mill to the sulphurous stream called the Yokegayney (Youghiogheny) River where coal boats were being unloaded at the rate of 2,000 tons per day, and here the party saw a fence made of a section of steel pipes and a section of iron pipes; the object being to see which should be more durable. After several years exposure, however, there does not seem to be any difference. The river scenery was not much, on account of the coal dust connected with it, so the party adjourned to the testing room where they were informed that the Bostons took the first game from the Athletics.

The test consisted in pulling on the one end of two pipes coupled together to see whether the pipes or the coupling would break. All bets were on the coupling and it won by the threads requiring a total load of 144 tons to break. Much more could be written about this interesting place if space would permit; however, this story would be incomplete if two of the best ways of spending money about a plant were left out. Every so often the president and board of directors of a railroad make inspection trips, and just before they start, word is sent out to the various section and yard foremen to clean up and show the boss how neat everything is and how well kept up. The National Tube Co. goes on the plan that what is good for the boss to see is good for the men to see, and keeps the yards attractive and clean, in fact only some additional grass and flowers are needed to make a park.

The second feature worthy of note is the temporary hospital where a nurse and doctor are ever in readiness to attend to the injured and where an ambulance with driver is in readiness at all times of the day and night to go after the badly injured and convey them quickly to the hospital, where, if necessary, they may be operated on. We wish to convey our thanks and those of the other visitors to the officers of the National Tube Co. and those in charge of the McKeesport Tube Mills for their courtesy in permitting us to see this model plant and for their kindly explanation of the machines and processes involved in the manufacture of "NATIONAL" pipe.

Columbia Section A.I.M.E. Meeting

The fourth annual meeting of the Columbia section, American Institute of Mining Engineers, was held November 27, 1914, at Spokane, Washington. Prof. Francis A. Thomson, head of the department of mines at Washington State College, was toastmaster, and L. K. Armstrong was master of ceremonies.

The principal address was made by Prof. F. M. Handy on the "Economic Geology of Eastern Washington."

Other speakers were Loren A. Campbell, of Rossland, B. C.; Oscar Lachmund, Greenwood, B. C.; Frederic Keffer, Greenwood, B. C.; G. H. Wyman, Jr., Wallace, Idaho; Sam H. Richardson, mining engineer, Republic, and Prof. D. C. Livingston, Moscow, head of the mining department, University of Idaho.

The report of the secretary-treasurer for the year showed that the membership had increased from 120 to 150, and that the section was in good financial condition.

F. A. Ross, of Spokane, was elected president; Rush J. White, of Wallace, Idaho, chief engineer for the Federal Mining Co., vice-president; and L. K. Armstrong, of Spokane, secretary-treasurer.

Candlepower of Lamps

The British safety-lamp committee considers that the minimum candlepower to be required of flame lamps should be .30 pentane standard, and that they should give this minimum for 10 hours.

The British standard candlepower is obtained from a sperm candle weighing 6 to the pound and burning at the rate of 2 grains per minute. The pentane bunsen standard has the equivalent of 1 British candlepower, hence the above is .3 of a candlepower.

The lamps tested varied between .325 and .065 candlepower, the higher figure being given with naphtha as fuel and the lower with a mixture of half colza and half paraffin.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Oil vs. Electric Safety Lamps

Editor The Colliery Engineer:

SIR:—I note with interest the article in your October issue comparing miners' oil safety lamps with the electric lamps.

Each have their appreciative value.

I appreciate the necessity for oil safety lamps in gaseous mines, but at this age for one purpose only, that is for testing gas. I claim that these oil safety lamps if placed in the hands of experienced men for the testing of gas only, and the electric lamp as approved by the United States Bureau of Mines, used for illumination, explosion hazards from lamps would be reduced to a minimum or eliminated entirely.

It is well known that many accidents have occurred through the so-called oil safety lamps, due to the defective assembling or to carelessness and inexperience on the part of the user.

In Miners Circular No. 12, of the United States Bureau of Mines, on "The Use and Care of Miners' Safety Lamps," James W. Paul, the author, states on page 3 that: "Safety lamps that were defective or were not properly cared for have caused a number of accidents in foreign coal mines. Many miners in the coal mines in this country have been burned with the flame of gas (methane) that was lit by opening a safety lamp or by not using the lamp properly.

"Safety lamps from which the gauze had been removed have been found in the hands of inexperienced or careless men in gaseous mines. And no doubt many mine disasters have been prevented by discovering such ignorant use of safety lamps and warning the men so carelessly inviting injury or death.

"Defects in miners safety lamps caused at least two disasters in this country in 1912. The lamps were of the modern type, burned naphtha or gasoline, and had a double gauze, a shield, and a glass globe. In each disaster a safety lamp ignited gas within a mine. In one case 12 lives were lost, and in the other case several men were severely burned.

"The first of the two disasters resulted from the parts of a lamp not being properly assembled. The top asbestos gasket was doubled on itself, so that a part of the glass did not touch the gasket and an open space was left between the top of the glass and the gauze. When this lamp with the gasket doubled back was lighted and placed in an explosive mixture of gas and air, the gas within the lamp flamed and ignited the gas outside the lamp.

"The second disaster was caused by a safety lamp that had not been properly assembled. In assembling this lamp the pull bar that works the scratcher for igniting the tape had been left out. This lamp when lighted and placed in an explosive mixture of air and gas ignited the gas outside the lamp.

"Miners safety lamps with the pull bar removed have been found in use in a number of gaseous mines. To use a lamp in this condition in a gaseous mine is very dangerous, because the lamp is then no safer than an open-flame lamp."

The electric lamp, as approved by the United States Bureau of Mines as permissible for use in gaseous mines, if not assembled correctly will not light. Oil or safety lamps without self-igniters if lighted with a match will endanger the lives of the men in the mines.

The electric lamp has yet to cause an accident, and is the only real safety lamp for use in mines, not only as to preventing explosions, but in saving many lives after an explosion.

In Technical Paper No. 75 issued by the United States Bureau of Mines on "Permissible Electric Cap Lamps for Miners," H. H. Clark, the author, says among other things that:

"Reports from mines where the lamps are being tried indicate that the men prefer portable electric lamps to safety lamps, and in at least one state the use of portable electric lamps in coal mines has been authorized by law. Therefore it seems reasonable to believe that the movement toward a general adoption of portable electric lamps, especially in gaseous mines, has begun and that the number in use will gradually increase.

"*Safety as a Feature of Miners Electric Lamps.*—To make an electric lamp acceptable for mine use, it must have a number of qualities. Chief among these is safety. The reason why the Bureau of Mines advocates the use of portable electric lamps is because the fire and explosion hazards will be decreased by their use.

"*Qualities Other Than Safety.*—The quality of safety, the most important attribute of the portable electric lamp, has already been discussed, but other qualities are desirable. The Bureau of Mines considers that a safe electric lamp is really a safety device whose universal adoption, in connection with a proper number of oil safety lamps for gas testing, will make coal mining conditions safer by reducing the fire and explosion hazards and by making easier the detection of bad roof. The bureau is therefore interested in the development of lamps that shall be not only safe but also otherwise fully suited to the requirements of mining service."

From Technical Paper No. 47, issued by United States Bureau of Mines on "Portable Electric Mine Lamps, H. H. Clark, author, the following abstracts are taken:

"There are two general classes of mine lamps, open-flame lamps, and safety lamps, with which portable electric lamps must be compared. The comparison with open-flame lamps may be briefly drawn. An electric bulb is obviously safer than an open flame, as regards the ignition of either firedamp or combustible material. For use on a cap, an electric lamp is, on the whole, nearly if not quite as convenient as the open-flame lamp.

"In comparing electric lamps and safety lamps the locked safety lamp must be considered as the only one that, for safety, is on a par with a well-constructed portable electric lamp. Even the locked safety lamp has its weak points. The omission or improper adjustment of some part may render the lamp unsafe and this condition may be effectually hidden from the user of the lamp and continue to exist until the lamp is reopened and readjusted. The user has no means of detecting imperfect arrangement of lamp parts and must depend upon the one whose duty it is to prepare the lamp for use. Reports indicate that safety lamps are not always properly adjusted in the lamp house and that they sometimes are issued in an unsafe condition. Just how often this occurs cannot be surely determined, because the condition is not always apparent unless it causes disaster.

"Although an electric lamp cannot be regarded as a safety lamp, if the latter is defined as a lamp that detects the presence of gas without igniting it, still if the presence of gas is known a well-constructed portable electric lamp, even without special safety devices, would seem to be quite as safe as a safety lamp; because, while either may possibly ignite gas as the result of an accident, an unbroken safety lamp may cause disaster if its parts are improperly arranged.

"If an electric lamp is so designed that its bulb cannot be broken before the filament ceases to glow, the danger of gas ignition is so completely eliminated that it is conceivable only as the result of malicious intent combined with the exercise of skill and ingenuity in restraining the action of the safety devices.

"As compared with the safety lamp, the electric lamp is the more convenient because it can be worn upon the cap. The direction of its light is then automatically governed by the movements of the wearer's head and both his hands are free. Another desirable feature of the electric lamp is that it gives more light than a safety lamp."

The recent mine disaster in Mulga mines of the Woodward Iron Co., Mulga, Ala., on October 5, proves conclusively the merits of the electric lamps under such conditions.

It was a most fortunate and peculiar incident that on the morning the explosion occurred, electric cap lamps were being demonstrated. The explosion was caused by a naked lamp, and of 300 men in the mine at the time all were saved but 17.

The men were able to light their way out with the electric lamps then being demonstrated. Due to this fact alone, is the small list of fatalities, 17 out of 300.

We all know what a poor light the flame safety lamp gives, also the disadvantages of carrying it in the hand and the advantages of the electric cap lamp which gives the miner the free use of both hands.

Users of so-called flame safety lamps complain about their eyes being affected due to the poor light. It stands to reason the atmosphere in a mine is certainly much clearer where electric lamps are used than when so-called flame safety lamps are used.

In Mr. Hailwood's article, he stated certain dangers connected with electric lamps. He certainly is in error if he means the electric lamps approved by the United States Bureau of Mines, which cannot ignite gas, on account of being constructed with safety attachments and circuit breaking devices.

In this age of progress and development, there is no good reason for the existence of the open-flame lamps in the mines, especially in gaseous mines. These lamps are tolerated simply for lack of something better. Man's ingenuity in its search for more worlds to conquer, never seemed to take the direction of this commonplace subject until some years ago, there was an electric miners' cap lamp placed in the mines, and today it has more than proved the ideal lamp for mines, minimizing the mine fatalities and making chances of fire remote. In every live mine in the universe there is room for a practical electric lamp which is convenient, economical, and safe under all conditions.

The electric mine lamp is gradually being and must surely become universally recognized as the most practical, most efficient, and by far the safest of all existing mine lamps of any class.

It is an indisputable fact that in every mine there is a light problem, whether the mine is anthracite or bituminous, gaseous, or non-gaseous, a small or large operation, the fact remains that the miners must be absolutely dependent upon artificial light in the execution of their work.

That the electric lamp is practical has been proven by the many thousands in use by a large number of coal operators throughout the country.

Is it not feasible to adopt a system which will enable the men to work under more pleasant and healthful conditions, giving them better light and above all, absolute safety? These thoughts are by no means visionary; they are worthy of careful consideration.

Such mine disasters as have recently occurred throughout this country should be a warning to all operators. Many of these companies having had explosions, have now installed electric cap lamps in their mines. The cost of the rescue work alone amounts to more than the cost of installation.

The electric lamp today is constructed in such a manner as to meet all working conditions in the mines. It is absolutely safe, and fool-proof and is the most practical device ever invented for the safeguarding of industrial life, health, and property. You know what little light the so-called flame safety lamp gives. Therefore better illumination will give increased production and greater efficiency among the workers.

I claim that three-quarters of the mine disasters can be eliminated by the universal use of the electric safety lamps of any make, approved by the United States Bureau of Mines.

"Safety First" is the slogan of the day. First aid to the injured is often heard. I say, first and above all should be "First aid to the uninjured."

Hiram H. Hirsch
Philadelphia

Coal Washer Efficiency

Editor The Colliery Engineer:

Sir:—I note the letter in the November issue by Mr. A. D. Macfarlane, E. M.

I agree with him that the 16-per-cent. washer loss, or refuse, quoted by Mr. Newell G. Alford is impossible according to the analyses given.

There are some slight errors in the calculations by Mr. Macfarlane as follows:

Macfarlane figures:

a = 590,097 tons;
b = 70,359 tons;
x = 94,983 tons;
y = 101,271 tons.

Correction:

a = 590,168 tons;
b = 70,367 tons;
x = 94,912 tons;
y = 101,263 tons.

This has a slight effect only upon the percentages of washed coal and refuse as stated by him, changing the washed coal from 77.09 per cent. to 77.10 per cent. and the refuse from 22.91 per cent. to 22.90 per cent.

The formula more commonly used to determine the washery loss, or more properly termed refuse, requires the use only of the percentages of ash in the raw coal, washed coal, and refuse and the calculation is therefore somewhat simplified as compared with the method presented by Mr. Macfarlane. By its use it will be seen that the percentage of refuse thus determined checks with Mr. Macfarlane's figure.

Let:

x = per cent. refuse;
y = per cent. washed coal;
a = per cent. ash in raw coal;
b = per cent. ash in washed coal;
c = per cent. ash in refuse.

Then,

$$x=\frac{a-b}{c-b}=\frac{.20034-.10653}{.51632-.10653}=\frac{.09381}{.40979}=.229=22.9 \text{ per cent.}$$

$$y = 100 - x = 100 - 22.9 = 77.1 \text{ per cent.}$$

The formula $x=\frac{a-b}{c-b}$ is derived from the equation $cx+by=a$.

In a similar manner the value of y may be determined and would result in $y=\frac{c-a}{c-b}$ but whichever formula is used, the value of the other material may more quickly be determined by subtracting the first from 100.

The equation $cx + by = a$ can also be solved in a similar manner to that used by Mr. Macfarlane and would result as follows:

It is, of course, true that $x + y = 100$.

Then:

$$\begin{aligned} x+ \quad\quad\quad y &= 1.00 \\ .51632x+.10653y &= .20034 \end{aligned}$$

or,

$$\begin{aligned} .51632x+.51632y &= .51632 \\ .51632x+.10653y &= .20034 \\ \hline .40979y &= .31598 \end{aligned}$$

$$y = 77.1 \text{ per cent.}$$

The value of x can, of course, be determined in a similar manner.

Personally, I would prefer to use the proximate analyses for checking up the refuse and washed coal percentages, or, if these percentages have been determined from actual weights, and if the weight of washed coal plus that of refuse equals the raw coal input, then the check would be on the analyses. Likewise, the use of the B. T. U. figures would more likely be a check upon them, a check upon the percentages of washed coal and refuse and the proximate analyses first having been obtained.

I cannot agree with Mr. Macfarlane in his definition of a theoretically perfect washer, or one having an efficiency of 100 per cent. He states that it would be an impossibility to separate, by washing, the heat units from the ash and this is undoubtedly true. The term efficiency, as applied to machinery, is taken to mean the ratio of the useful to the total work performed by the machine, or this might be more clearly expressed as the ratio of the useful to the possible work performed.

If such a plant as he mentions is known to be an impossibility, why consider it as one of 100-per-cent. efficiency? Furthermore, in the washing of bituminous coal which is to be used for the manufacture of coke it is frequently possible to reduce the ash content of the washed coal so low as to result in an inferior coke. In fact, it is questionable whether any coke containing *no* ash would be fit for use in metallurgical work, and it would therefore again seem wrong to consider the 100 per cent. efficient washery as one making a complete separation of the heat units from the ash.

I have frequently expressed my views of coal washing efficiency in the engineering journals, so will not go into that here, but expect soon to have some additional data along these lines which will cover the opinions of a number of others either interested or actively engaged in coal washing.

G. R. Delamater
Consulting Engineer
Harrisburg, Pa.

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A small pile of coal cooled down from 165° F. Usually when coal heats to 150° its heat increases rapidly and when 212° is reached the coal must be moved to prevent fire.

ANSWERS TO EXAMINATION QUESTIONS

Questions Selected From Those Asked at an Examination for Mine Foreman, Held in Price, Utah, September 15 and 16, 1914

(Concluded from December issue)

QUES. 1.—In event of your fire bosses finding danger from gas, bad roof, or other causes, what precautions would you insist upon them taking to keep working men from these places?

ANS.—If the dangerous condition affects an entire district, as an entry and all the rooms thereon, it would be well, in addition to placing the usual barricades, danger signals, etc., at the mouth of the entry, for one of the fire bosses or some one appointed by him to stand at that place to personally warn the men to keep out of the dangerous district. If the danger affects but one room, it is generally only necessary to place obstructions with the proper notice across the mouth of the place; although it would be safer to personally warn the men working in the room not to enter it.

QUES. 2.—What is meant by (*a*) splitting the air; (*b*) what advantages are derived from such a method?

ANS.—(*a*) By splitting the air is meant its division into a number of separate or distinct portions each of which is used to ventilate a particular part of the mine. That is, each entry, for example, is ventilated by its own current of air which enters it from the main intake and which passes from it into the main return without having previously passed through or without afterwards passing through any other workings. In the older continous system of ventilation, the air-current passes from the main intake through all the workings in order, and thence into the return.

(*b*) Among the advantages of splitting the air are: A larger amount of air is circulated for the same power; the ventilation is more easily controlled, as each district is independent of all the others; each district gets purer air, as the bad air from any one district is conducted at once to the main return without passing through the other workings; in event of an explosion in any one district there is the possibility that its effects may not spread to other parts of the mine; in comparison with the continuous system of ventilation, a larger volume of air moving at a reasonable velocity is conducted through the workings, which is an advantage in gaseous mines worked with safety lamps.

QUES. 3.—(*a*) Explain the formula for finding the weight of air per cubic foot at different temperatures, and under different pressures. (*b*) Find the weight of 1 cubic foot of air at 60° F., barometer 30 inches.

ANS.—The formula generally used for finding the weight w, in pounds, of 1 cubic foot of air at any temperature in Fahrenheit degrees and height of the barometer, in inches, is,

$$w = \frac{1.3273 \times B}{460 + t}$$

in which,

B = height of barometer, in inches;
t = temperature, in degrees F.

The weight of 1 cubic foot of air when the barometer is 1 inch and the temperature is 0° F. absolute is 1.3273, that is at 460 degrees below zero. Since the weight of any given volume of air increases directly as the pressure and inversely as the absolute temperature, the weight of 1 cubic foot of air at the unit pressure and temperature (1 inch of the barometer, and minus 460 degrees) is multiplied by the height of the barometer and divided by the absolute temperature or by $460 + t$, in order to obtain the weight of the same volume of air at the increased pressure and temperature.

By substituting in the formula, the weight of 1 cubic foot of air at 30 inches pressure (barometer) and at a temperature of 60° F., is found to be

$$w = \frac{1.3273 \times 30}{460 + 60} = .0766 \text{ pound, about.}$$

QUES. 4.—If you were a mine foreman in a gaseous mine, how would you arrange and distribute the air-currents to insure the greatest safety to life and property?

ANS.—The air-current should be divided into a series of splits, one for each district; overcasts should be used in place of doors; brattices should be built in all breakthroughs as soon as the next breakthrough inby is driven through the pillar; the brattices should be air-tight; each district should get the proper amount of air which should be sufficient in velocity. By these means each district will get pure air; there will be no derangement of the air through doors being left open; the air will be kept up to the face where it is needed; there will be no loss of air by leakage; and there will be enough air moving at the proper speed to keep the working faces clear of gas and smoke.

QUES. 5.—There is passing through an airway, 35,000 cubic feet of air per minute. What will be the velocity per second, if the size of the airway is 7.5 ft. × 5.5 ft.?

ANS.—The area of the airway is $7.5 \times 5.5 = 41.25$ square feet. The

velocity of the air per minute is $35,000 \div 41.25 = 848+$ feet; and the velocity per second is $848 \div 60 = 14.13+$ feet.

Ques. 6.—What are the important factors necessary to secure good ventilation at the face of the mine, and not get too high a water gauge, providing the amount of air entering the mine is adequate?

Ans.—Any means that will reduce the friction of the air in its passage through the mine will reduce the water gauge. The friction and, consequently, the water gauge may be reduced by splitting the air instead of conducting it in a continuous current through the workings; by driving the entries as straight and as smooth as possible; by making the return air-courses as large as the intake airways, and by making all the airways as large as is consistent with the economic mining of the coal. To get the air to the face, the brattices between the room and back heading must be air-tight.

Ques. 7.—Give the names, chemical symbols, and composition of the different gases found in mines, and under what conditions they are found.

Ans.—Aside from the oxygen and nitrogen which make up the atmosphere, the chief gases found in mines are as follows: Methane, or marsh gas, which when mixed with air is known as firedamp. When gas is spoken of, methane is intended. Its symbol is CH_4, indicating that it is composed of four parts of hydrogen and one part of carbon. It is commonly found in seams under considerable cover and, because of its lightness, in workings driven to the rise and near the roof.

Carbon dioxide, which when mixed with air is called blackdamp. Its symbol is CO_2, indicating that it is composed of two parts of oxygen to one part of carbon. It is always present to a slight extent, even in pure outside air. In mines, it is found in the afterdamp of explosions and fires, in powder smoke, in the gases given off by the breath of men and animals, in the flame of lamps, etc., and, because it is heavier than air, it is usually found in dip workings and near the floor.

Carbon monoxide, which when mixed with air is known as whitedamp. Its formula CO, indicates that it is composed of equal parts of carbon and oxygen. It is a universal constituent of the afterdamp of a coal-dust explosion, it is present in the smoke of some explosives, and is given off by gob fires. As it has about the same specific gravity as air, when present at all, it is as likely to be found in one part of the workings as another.

Ques. 8.—Suppose that an outburst of gas should occur from a cave or other cause and suddenly accumulate in the workings, naked lights being used. What precautionary steps would you take to safeguard the men and remove the gas, and render it safe for men to proceed to work?

Ans.—All open lights should be extinguished at once and the men taken from the mine by way of the workings that contain the least gas. The amount of air in circulation in the affected entry should be increased by speeding up the fan or by adjusting the regulators at the mouth of the entry. If this does not reduce the gas, which may come from the exposure of a blower, it may be necessary to seal off the affected area until the blower exhausts itself. Only skilled men, and as few of them as possible, who should work with safety lamps or storage-battery electric lights, should be employed for the purpose.

Ques. 9.—Describe fully the construction of (*a*) the Davy safety lamp, and (*b*) the Wolf safety lamp, noting the difference between the two.

Ans.—The Davy lamp consists essentially of a metal chamber filled with oil, which is provided with the necessary wick, etc. Attached to the upper part of the oil chamber by means of a screw joint is a cylinder of wire gauze about 1½ inches in diameter and from 4½ to 6 inches in height. The wire gauze is of No. 28 mesh, that is, it has 784 openings per square inch of surface, and the upper part of it is usually protected by an additional outer covering of the same material. There are three standards holding in place the upper and lower rings which support the gauze; there is a sheet-metal hood over the top of the gauze to protect it from dropping water; and to the hood is fastened a metal ring by which the lamp may be carried.

(*b*) In the Wolf lamp the oil chamber is surmounted by a glass chimney above which comes a gauze cylinder of the same material as in the Davy lamp. This constitutes the lamp proper. The gauze is protected by a bonnet of corrugated metal provided with a hood to which is fastened the handle for carrying the lamp. The lower part of the bonnet terminates in a metal ring to which are fastened the upper ends of four equally spaced standards, the lower ends of which are soldered to a lower ring by means of which the bonnet is screwed to the lamp proper. The lamp is provided with a magnetic lock so that it can be opened only by means of a powerful magnet kept in the lamp house, and has a friction igniter by means of which the lamp may be relit when extinguished. The lamp uses naphtha as an illuminant.

The Wolf lamp differs from the Davy in giving very much more light, in the magnetic locking and relighting devices, and in being safer in air-currents of medium and high velocity. It is not quite so sensitive to gas.

Ques. 10.—(*a*) State two essentials for a working (general use) safety lamp. (*b*) Explain how safety lamps should be tested at the mine.

Ans.—(*a*) Two of the numerous essential features are that the lamp must give a good light and must be safe under all ordinary conditions in which it may be used.

(*b*) Safety lamps are not usually tested at the mine. They are commonly inspected to see that the gauze in particular has been cleaned and is free from grease; that the gauze is not broken in any way; that

the oil chamber has been filled; that the wick is clean; that the lamp is locked and is, further, properly put together so that no air can reach the flame without passing through the gauze.

QUES. 11.—In replacing broken timbers, either props or cross-bars, what precautions should you take to protect your men engaged at that work?

ANS.—In replacing broken timbers of any kind, the roof should be carefully examined and the men, from a place that is safe, should bar down all loose rock. In some cases, the broken timber will have to be pulled out with a mechanical device, its removal resulting in a fall of roof. In other cases, temporary timbers may have to be set to protect the men while removing the broken timbers or while drilling holes to blast down larger and more tenacious masses of roof.

QUES. 12.—Why are doors used in a mine?

ANS.—Doors are used in mines to deflect a current of air from the course it would otherwise take, and form part of the ventilating system. A door would be placed across the main intake, for example, to turn the air into a cross-entry. Doors are now, as far as possible, replaced by overcasts. Doors are also used in place of permanent brattices where a haulageway has to be maintained between two parallel entries.

QUES. 13.—In a timbered airway, the collars measure 7 feet between the notches and the spread of the legs is 10 feet wide at the bottom, the height from top of rail to under side of the collar is 6 feet, and the velocity of the air is 400 feet per minute. What is the sectional area of the airway, and what is the quantity of air passing?

ANS.—The average width of the airway is $(7+10) \div 2 = 8.5$ feet, and its height is 6 feet. Thence, its area is $8.5 \times 6 = 51$ square feet. The quantity of air passing is equal to the area of the airway multiplied by the velocity of the air, or to $51 \times 400 = 20,400$ cubic feet per minute.

QUES. 14.—What is coal dust?

ANS.—Coal dust is coal in sufficiently small particles to be carried by the air-current in a mine so that it is or may be deposited at a distance from the place where it was made, depending upon the fineness of the dust and the velocity of the air-current. It is universally present on the roof, floor, ribs, timbers, etc., of mines, where it is produced in undercutting and blasting the seam and by grinding and crushing of lumps of coal on the floor by passing men, animals, cars, motors, etc.

QUES. 15.—In what manner does coal dust assist an explosion?

ANS.—The dust of bituminous coals, when in very small particles and suspended in the air, acts not unlike a body of gas. An explosion of firedamp will ignite the dust near it. Part of the dust will be burned to carbon monoxide, itself an explosible and combustible gas, and from part will be distilled the volatile matter, which is also combustible. The burning of the gases thus produced ignites more dust and produces more gas, the burning of which ignites more dust, etc. In this way, the effects of the explosion of a comparatively small body of methane may be carried throughout the entire workings of a mine, and is only stopped when the supply of dust gives out or there is not enough oxygen to burn the dust which is present. The action is so rapid, the explosive wave moving at the rate of 15 to 20 or more miles a minute, as to be practically instantaneous.

QUES. 16.—State fully three ways in which an explosion can take place in a coal mine, with coal dust as the main factor, without the presence of firedamp.

ANS.—The ignition of coal dust followed by an explosion requires heat which may be produced by the flame of a blown-out shot, by the explosion or burning when unconfined of dynamite, powder, and other explosives, by a mine fire, and by the electric arc produced when a current of electricity is short circuited.

QUES. 17.—State briefly two instances where such an explosion, as asked in the former question, have occurred.

ANS.—The explosion at Monongah, W. Va., on December 6, 1907, in which 361 men were killed, was a dust explosion. The dust is believed to have been ignited by the electric arc produced when the trolley wires came in contact when their supports were knocked out by a run-away trip on the main hoisting slope. The explosion at Delagua, Colo., on November 8, 1910, in which 79 were killed, was also a dust explosion, but the original cause was a mine fire, into the flame of which was suddenly drawn a large volume of coal dust.

QUES. 18.—If such explosions are liable from coal dust, what, in your opinion, is the best way to prevent them?

ANS.—Coal-dust explosions may be reduced in number, if not entirely done away with, by (*a*) preventing the formation of dust, and (*b*) by rendering harmless such dust as may unavoidably be formed.

A reduction in the amount of dust formed may be accomplished by undercutting and shearing the seam before blasting; by using permissible powder in the smallest possible charges in well-placed and well-tamped holes; and by transporting the coal in tight cars which are not overloaded, so that neither fine coal nor lumps will fall on the track to be ground into powder by passing traffic.

The ignition of the dust may be prevented by removing it from the mine, that is, by loading up and carrying out all machine cuttings, road cleanings, and the like. What dust remains may be rendered harmless by washing down the roof, floor, and ribs with water as often as is necessary to keep the dust thoroughly wet; by wetting down the rooms for a distance of from 50 to 80 feet back from the face; or by treating the coal dust with enough powdered shale to render the dust inert and non-inflammable.

Any rules that will reduce the number of mine fires, blown-out shots, explosions of powder, electric

short-circuits, etc., gas explosions, etc., will reduce the number of dust explosions and should be adopted.

Finally, if the blasting is done by electricity from some point outside the mine after all the men have left the workings, there will be no fatalities even if, in spite of all precautions, an explosion does take place.

Legal Decisions on Mining Questions

Legal Method of Determining Width of Barrier Pillar.—(Pennsylvania) Bill in equity by the Mill Creek Coal Co. against John Curran, State Mine Inspector, to declare illegal an award fixing the width of a barrier pillar of coal between the mines of two operating companies. The Penna. Law (Acts 1891, Section 10, Article 3) in substance provides that in cases where the property of two operating companies adjoin, the width of a coal barrier wall to be left between them shall be determined by a tribunal consisting of the inspector and one engineer from each company. The claim as made by the plaintiff Mill Creek Coal Co. was that in settling the matter as to the width of the barrier to be left between its mine and that of the Dodson Coal Co., whose property adjoined, the inspector and the engineer of the Dodson Co. agreed that a barrier 300 feet should be left between the two properties, though in fact the engineer of the plaintiff company refused to consent to a barrier of this width, claiming the same absolutely unnecessary. On this ground the plaintiff claims that the determination of the inspector and the engineer of the Dodson company was illegal, for the reason that the engineer of the plaintiff company would not join in the same. The Supreme Court of Pennsylvania held that a majority of the members of the tribunal created by the act, are sufficient to render a valid decision fixing the width of the barrier pillar between the two adjacent mines, providing that all members of the body had an opportunity to participate in the deliberations. The fact that plaintiff's engineer could not agree to the determination as arrived at by the remainder of the tribunal does not invalidate proceedings.—*Mill Creek Coal Co. vs. Curran, et al. 91 A. 424.*

Proper Remedy to Determine Title to Mine Property.—(Pennsylvania) In an action brought by a coal mining company to enjoin another company from mining coal under its land, a suit in ejectment is the proper remedy to determine the disputed title depending on the true boundary line between the adjacent properties.—*Lehigh Valley Coal Co. vs. Midvalley Coal Co. 91 A. 427.*

Injunction Denied. — (Pennsylvania) Where an owner of a dwelling house sued for an injunction to restrain defendant coal company from working its colliery near his residence, a preliminary injunction was properly denied, where the injuries to plaintiff were not of a pressing nature, and an injunction would stop the mining operations of defendant, throw a large number of employes out of work, and cause a large loss to the defendant, and the injuries complained of had been endured for some time.—*Alexander vs. Wilkes-Barre Anthracite Coal Co. 91 A. 213.*

Termination of Mineral Lease. (Louisiana) An oil and gas lease which stipulates that it is to continue during the time that gas and oil are found in paying quantities is at an end, and will be annulled, when the time during which the lessee has a right to exploit the land has expired, and no gas and oil have been found.—*Cooke vs Gulf Refining Co. 65 S. 758.*

Taxation of Mining Companies. (Oklahoma) Act of the Oklahoma Legislature (Laws 1907, c. 71, art. 2, pp. 640-645) providing for the levy and collection of a gross revenue tax from persons, firms, corporations, or associations engaged in the mining or production of coal, asphalt, or ores bearing lead, zinc, jack, gold, natural gas; is not repugnant to Section 57, Article 5, of the Constitution.—*McAllister-Edwards Coal Co. vs. Trapp. 141 Pac. 794.*

PERSONALS

Charles M. Barnett, formerly president of the Chesapeake & Ohio Coal and Coke Co., has been made president of the Atlantic States Coal and Coke Co., at Richmond, Va.

After January 1, Delwyn Wolfe, of Mahanoy City, division engineer of Delano division of the Lehigh Valley Coal Co., will assume charge of all the Lehigh-Coxe Division mines at Hazleton, to succeed Thomas R. Jones, who will become superintendent of the Delano division.

James S. Thompson, formerly of Colorado, has accepted the position of general superintendent for the Utah Fuel Co., with offices at Castle Gate, Utah.

J. F. Welborn, president of the Colorado Fuel and Iron Co., has appointed David Griffith, former state mine inspector, as welfare commissioner, whose duty will be to hear grievances and to act as intermediary between the company and its employes.

Frank Pardoe has been appointed assistant general manager of the mines of the Rochester & Pittsburg Coal and Iron Co., in the Jefferson County district, Pa.

Leo Gluck has resigned from the position as assistant to the president of the Pittsburg Coal Co., and has gone into the business of consulting mining engineer. Mr. Gluck has been actively engaged in mining since his graduation in 1889 from Washington University, St. Louis, Mo. Mr. Gluck is succeeded by S. C. Gailey, formerly vice-president of the Sunday Creek Coal Co., of Columbus, Ohio.

Samuel Dunkerly, of Hazleton, Pa., died recently. He was inside superintendent for the G. B. Markle Co. operations for 30 years.

The Pocahontas Consolidated Coal Co., of West Virginia, announces the appointment of Robert Wallace as general superintendent and R. C. Confer as chief mine inspector.

NEW MINING MACHINERY

The Bartlett-Graver Water Softener

The Wm. Graver Tank Works installed Bartlett-Graver softeners at Nos. 1 and 2 mines of the United Coal Mining Co., near Christopher, Ill. The water in the vicinity of the mines was corroding the boilers to an alarming extent. Its analysis showed the following ingredients:

	Grains Per U. S. Gallon
Calcium carbonate	2.93
Calcium sulphate	7.40
Magnesium sulphate	9.75
Silica	.21
Iron and aluminum oxides	.04
Suspended matter	3.00
Total	23.33

Calcium oxide is deposited from the soluble carbonate when the carbon dioxide is expelled from the water by heat. When alone, it is usually deposited in the form of loose powder, but in combination with other ingredients it forms a hard scale.

Calcium sulphate is precipitated from solution in a crystalline condition by the combination of heat and concentration, and forms a scale of great hardness.

Magnesium sulphate does not form a scale itself, as it is very soluble. However, when in water, a reaction takes place forming magnesium hydrate and calcium sulphate, both of which are precipitated in the form of a hard scale.

Iron and aluminum oxides form a scale by being precipitated through soluble carbonates in the same manner as is calcium oxide from calcium carbonate.

In addition to the above there is always a possibility of the water containing free acids, such as sulphuric acid, etc., that will pit and corrode the boiler. The water, as may be noted by the analysis, is exceptionally high in calcium and magnesium sulphates, which would result in a boiler scale that is hard almost like porcelain.

Considerable sodium chloride (common salt) was found in solution. This is not incrusting, but is corroding, and causes foaming. The water to be treated flows from the storage tank to the chemical tank, then to the reaction and settling tank, and finally to the filter. The

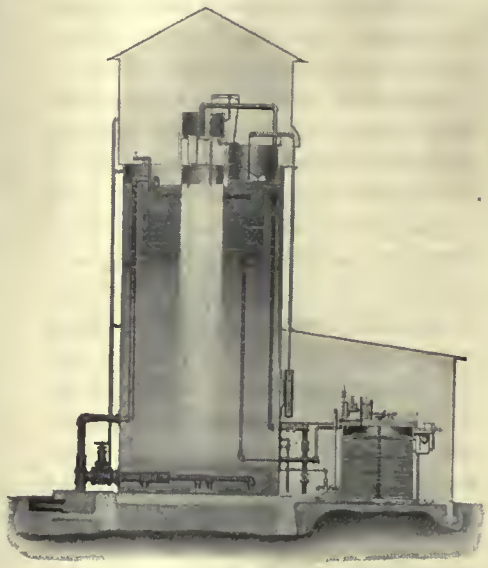

Fig. 1. Bartlett-Graver Water Softener

entire operation is continuous. The chemicals (hydrated lime and soda ash) are automatically proportioned to the quantity of water entering the apparatus. Subsequent sedimentation and filtration are accomplished without any interruption in the flow. The amount of ingoing water is always the same as the amount of softened water withdrawn.

A noticeable feature is the use of alum which coagulates the suspended matter in the water and carries it to the bottom of the tank.

The softeners at the Christopher mines are entirely ground operated. The chemical tank and all valves for filter washing and preparing the chemical charge, are on the ground level. The power necessary to drive the apparatus in mixing the chemicals is derived from a 1-horsepower steam engine, mounted as an integral part of the tank.

The result of the installation at Christopher was the reduction of the hardening ingredients to 2½ or 3 grains per gallon and the complete elimination of suspended matter.

"Precision" Efficiency Kit

The demand for more accurate boiler control by engineers either in a consulting capacity or in direct charge, has created the necessity for a serviceable testing apparatus. This must be compact in form and always ready for immediate use.

In determining the efficiency of a boiler it is necessary to know: (1) An analysis of flue gases, (2) the draft above the grate, (3) the draft back of the damper, (4) the differential, and (5) the temperature of the flue gases.

The "Precision" efficiency kit manufactured by the Precision Instrument Co., includes an Orsat apparatus for analyzing the gases, an accurate differential draft gauge and an encased thermometer. Besides this, the chemical reagents, rubber tubing, etc., are included.

Slick Steel Mine Tie

The Slick steel mine tie shown in Fig. 2 is the invention of E. E. Slick, vice-president and general manager of Cambria Steel Co., Johnstown, Pa. These ties may be made for any gauge of track desired, the most popular sizes for mine work, however, are 3 feet to 3 feet 9 inches gauge.

A tie of this kind with fastenings complete will only weigh 10 pounds, as compared with a 3″×4″ wooden tie, which weighs from 14 to 16 pounds, dependent upon the kind of wood. These are for 3-foot gauge.

One advantage claimed for this tie is that the fastenings are secured in such a way that they are always in place, ready for use and cannot become detached and lost. The small spikes used for securing rails to wooden ties are seldom used more than once, as they become broken, bent, or lost.

These ties are made in two different ways: one for intermediate ties to carry the continuous portions of the rails; while for joint ties for ordinary work, such as in rooms, four clips are provided, two for each end of each rail, so that no fishplates or other rail splices are needed, but the rails may be set end to end on the tie and made fast by the buttons. The buttons are turned with comparative ease by means of an ordinary long-handled wrench and they are put on in such a way that the friction of the rivet which holds them is enough to secure them in any position to which they may be turned.

Before riveting the button fastenings in place on the tie, the surfaces of the tie itself and the interior surface of the hole which is punched therein, are made smooth and the pressure of either cold or hot riveting of the buttons is so adjusted that the final pressure between the contacting surfaces of the rivets and the tie is such that the friction caused by the pressure is considerably less than the torsional stress of the shank portion of the rivet which passes through the hole in the tie. This, therefore, provides a button fastening which is held in any position desired by frictional contact, but which at the same time may be turned by means of a wrench contacting with its upper portion to open or close the fastening without twisting off the shank.

In certain cases flat washers may be provided under the rivet heads, or they may, previous to being riveted in place, be slightly bent concave. This latter form produces a certain kind of spring action which gives turning friction to the fastening, while at the same time allowing the button to be turned without twisting off the shank of the rivet.

Another advantage of the tie is its lightness, yet at the same time it has all the necessary strength and stiffness, the latter being augmented by the downwardly projecting flanges on the edges of the tie and by the longitudinal depressed portion formed intermediate to the flanges as illustrated in the drawing.

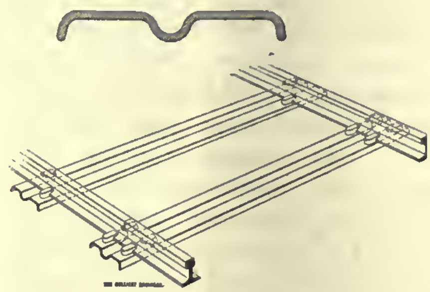

Fig. 2. Slick Steel Mine Tie

When used in mines, it is preferable to make the depth of the tie only about ½ inch, which gives a great advantage in small seams or openings as compared with a wooden tie, which is at least 3 inches in height. In medium-size coal seams where it is necessary to have mine cars of the largest capacity, the tie gives an additional clearance for the cars of at least 2½ inches and this will allow the loader to shovel coal into the cars more easily on account of the greater clearance and also permits larger lumps to be put into the car over the side.

On account of the small height of these ties they may be laid directly on the floor of the mine, whereas in many cases, channels have to be dug in the hard stone or clay of the mine bottom to receive wooden ties. On account of the thinness of these steel ties, only one-half inch, they may be spaced at least 8 feet apart, for mine-room work, and in that case the lower flange of the rail will rest on the bottom of the mine between the ties, thus providing the maximum clearance between the top of the car and the roof.

Experience with mine ties throughout Pennsylvania has conclusively shown that the miners themselves much prefer these steel ties to the wooden ones, as they are easily put in place, give greater clearance as above described, the fastenings are always ready and the miner's work greatly facilitated. In various mines throughout Pennsylvania, where wood ties have been used for years, but where some steel ties have been supplied during recent years, the miners have thought so much of the steel ties that they actually fight for them and steal them from each other, and if necessary, hide them so as to be ready at hand for their service in mine rooms when required.

The life of a steel tie is very much greater than that of a wooden tie; but, of course, this depends upon the conditions. In certain mines throughout Cambria County and elsewhere in Pennsylvania, where the rooms are dry, it is reasonable to believe that these steel ties will last for 10 years. In wet locations, however, where the water is very sulphurous, the ties would not last so long. Mine rooms, however, are generally dry and there is no question, all things considered, but that steel ties are much better adapted for use in such places.

Under present conditions of wooden tie supply, it is very difficult to obtain wooden ties when desired, and timber tract owners, farmers, and others seem to think it a favor to supply wooden ties to mines, and only do so when it suits their convenience. The supply of timber is, of course, decreasing, and as years go on the prices will be higher and the quality worse.

In various mines with medium-size coal seams, throughout Pennsylvania and elsewhere, it has been the experience that where wooden ties are laid on the room floor, it has been impossible to introduce a mining machine into the room on account of the necessary height of the machine, whereas with steel ties and the greater clearance, the same mining machine can be used, and this alone is sufficient to recommend the use of the steel tie in such locations.

The steel mine ties weigh less per tie than the wooden ties, only take up about one-sixth as much room, are

consequently more easily transported into the mine and only require a small fraction of the storage room in the mine that is needed for wooden ties.

A safe and conservative estimate of the money value of the steel ties as compared with the wooden ties is given below:

Comparison of Cost of Wood Ties and of Steel Ties for Use in Mine Rooms at Present Prices, Together with Estimates, Savings Per Year, 5, 10, and 20 Years, Due to the Use of Steel Ties

Wood Ties for 36-inch Gauge Track	
For one mine room, 300 feet of track.	
Wooden ties, 3 in. × 4 in., 4 feet center to center = 75 ties @ 6½c.	$4.88
300 spikes, 2½ in. × ⅜ in., 50 pounds	1.00
Labor, laying ties, rails, and driving spikes	4.80
Total above	$10.68
These wooden ties can be taken up and used in about two or three rooms, which means about one year of use, so that they will have to be replaced each year and the replacement cost each year would be	$10.68
The replacement cost of wood ties for 5 years, with interest compounded semi-annually @ 6 per cent. would be, on the above basis	$63.81
Steel Ties for 36-inch Gauge Track	
For one mine room, 300 feet of track.	
Steel ties for 36-inch gauge track, 8 feet center to center = 38 ties, at 10 pounds @ 30c. each	$11.40
Labor, laying ties, rails, and driving spikes	$ 2.40
The steel ties will last at least 5 years, so that the replacement charge annually will be	$ 2.76
And for 5 years, the cost of steel ties with interest compounded semiannually, at 6 per cent., would be	$31.45
The saving for 5 years, due to the use of steel ties, for one mine room, 300 feet of track, is	$32.36
The saving, due to the use of steel ties for 10 years, is	$75.66
The saving, due to the use of steel ties for 20 years, is	$211.16
In one of the larger mines of, say 400 rooms, of average length of 300 feet, there would be a saving in 20 years due to the use of steel ties, of	$42,232.00

Catalogs Received

Gardner Governor Co., Quincy, Ill. Gardner-Rix Vertical Air Compressors, 16 pages; Gardner Duplex Power Pumps, Circular P-8, 8 pages; Gardner Duplex Steam Pumps, Circular P-3, 8 pages.

Baldwin Locomotive Works, Philadelphia, Pa. Baldwin-Westinghouse Electric Mine Locomotives, 33 pages.

J. C. Stine Co., Tyrone, Pa. J. C. Stine Patented Disk Fans, Bulletin No. 18, 24 pages.

Hess-Bright Mfg. Co., Philadelphia, Pa. "Ball Bearings and Their Correct Use," five sheets describing the application of ball bearings to various machines.

Trade Notices

The Goulds Mfg. Co., manufacturers of triplex, centrifugal, hand and spray pumps, announces the opening of a new office in Atlanta, Ga., in the Third National Bank Building. It will be in charge of Mr. O. B. Tanner, District Manager. The company also has announced that Mr. F. L. Bunton, formerly manager of the Chicago office of the Heine Boiler Co., has resigned from that company to become manager of the Chicago office of the Goulds Mfg. Co., 3801-3811 S. Ashland Avenue, Chicago, Ill., manufacturers of pumps and hydraulic machinery. Previous to his connection with the Heine Boiler Co., Mr. Bunton was for 8 years manager of the Philadelphia and St. Louis offices of the Allis-Chalmers Co.

The Joseph Dixon Crucible Co., of Jersey City, N. J., is using a mailing card to introduce Dixon's boiler graphite to engineers and others interested in cleaner boilers. Dixon's boiler graphite is said to reduce fuel consumption, prevent the hardening of scale, give to the surface of the boilers a smooth polish, prevent pitting, and make the removal of scale easy by a gentle, mechanical action. Write for the Dixon booklet "Graphite for the Boiler."

The Weston Electric Co. starts the new year by distributing the first edition of its 1915 Electrical Supply Year Book. This company has adopted the policy of issuing an annual catalog which will give consumers the most recent information obtainable on the materials in the electric supply field. In place of the manufacturers' list prices which catalogs of this kind have heretofore invariably carried, this new book announces a complete series of Western Electric list prices upon which a uniform basic discount applies, such a discount indicating to the holder of the catalog the approximate price on all the articles listed. It is significant that at last some one in the electrical field has had the farsightedness to initiate and the ability to carry out a comprehensive plan of readjusting the present confused price situation in the electrical field.

In the 3,289 coal mines in Great Britain, 177,849 persons were killed or injured in 1913, or 54 for each mine. In the 817 mines in West Virginia, in the same period, 976 persons were killed or injured, an average of 1.20 for each mine, or 52.80 better than England. The British report also sets forth that for every 1,000 persons employed in the mines in the United Kingdom, 190 were either killed or injured, as against 18 in West Virginia, making more than ten men injured in each 1,000 British miners to one in each 1,000 in West Virginia.—*P. & B.*

Book Review

A review of the latest books on Mining and related subjects

Electricity in Coal Mining, by David R. Shearer, E. E. Published by McGraw-Hill Book Co., 75 pages illustrated. Price, $1.50 net.

In thirteen short chapters, the author explains the essential theories and methods of power transmission, direct and alternating-current calculations, signal systems, power plant designs, etc.

The importance of a colliery repair shop is emphasized. The author points out some possible defects about such a shop that would be classed as disadvantages. He says "such a shop is a doubtful benefit, for much of the work turned out is inferior, both in material and workmanship."

The final chapter on the fundamentals of efficient operation is excellent, and the key note of such operation is sounded by the author's statement: "The plant should be carefully designed by one cognizant of the duties imposed upon it."

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A Big Consumer's Storage Yard

Handling Large Quantities of Coal at the New York Edison Co.'s Plant at Shadyside, N. J.

By J. F. Springer

THE New York Edison Co., one of the largest electric light and power concerns in the world, serves Manhattan Island from 135th street south to the Battery. In this area there is a population of perhaps 2,000,000 using electric current on a prodigal scale. Not only has this one company the general task of supplying current; but it must not fail even transiently. Such vicissitudes as strikes in the mines, strikes on the railroads, and snowbound traffic, must not reduce the output of current for a month or a week or a day. Further, the company's consumption of coal varies with the time of the year—it is much greater in winter than in summer, and this distribution of its needs does not correspond any too well with the natural movement of coal from mines to tidewater. In view of the entire situation, it is necessary to maintain a large storage yard at a point convenient for both receiving and delivering.

The generating plant is at Waterside, in the lower part of Manhattan on the East River front, where a small storage yard is maintained, but which is insufficient to meet the general situation described above. The coal roads all reach tidewater either on the New Jersey or Staten Island shores, so that all coal must be discharged and water borne to enter Manhattan. The principal storage yard is neither at the generating plant nor close to the railway terminals, owing to the value of water-front real estate, but is located at Shadyside, opposite

Fig. 1. Coal Storage Plant of New York Edison Co., Shadyside, N. J.

110th street, about 6 miles north of the Battery, on the New Jersey shore.

Here the company is now using a water front of 486 feet, while the yard stretches inland 134 feet. Additional storage area is being added on the north, and when this is equipped with coal handling devices the total frontage will be something over 800 feet, and the whole yard will then have a capacity of 265,000 tons, instead of the present capacity of 150,000 tons.

The present yard has a rectangular space or water frontage of 397 feet and a depth of 200 feet, which constitutes a dock storage yard having a capacity of 40,000 tons. To the rear of this is the storage yard with a capacity of 110,000 tons.

On the dock front two machines are provided for unloading coal from river barges. One of these machines is a steam-operated bridge tramway, having a span of 200 feet, which travels on tracks parallel to the dock front and which commands under its span a storage area of about 40,000 tons capacity, so that this tonnage of coal can be unloaded from barges directly to the storage area, or can be reloaded from the storage pile directly to barges. The tramway, equipped with a 2-ton clam-shell bucket, has a handling capacity from barge to storage pile of 150 tons an hour, and is capable of delivering from storage pile to barges, 250 tons per hour. This tramway can also be used to unload coal from barges for delivery to that part of the storage area more remote from the water front which is not covered directly by the tramway.

Fig. 2. Preparing to Shift Grip from Empty Car to Other Cable

Fig. 3. Raising Coal from Hold of Barge

The second unloading machine on the water front consists of a high-speed, stationary, steam-operated, steeple tower, equipped with 1½-ton clam-shell bucket. This is shown to the right in Fig. 1. Its function is to supplement the tramway in unloading coal from the barges for delivery to the storage area not commanded directly by the tramway. All coal stored on the back of the property is therefore unloaded from the river boats, either by the tramway or the steeple tower, and from either of these machines, or both, it is delivered to cable cars which pass under the loading hoppers, shown in Fig. 2, on each of the unloading machines, and which carry the coal received back to the dumping trestle which is at right angles to the river front on the center line of the property. The cable cars, shown in Fig. 4, dump their load from this trestle and thus form a pile from which either of two traveling revolving cranes handles the coal for distribution over the entire storage area.

The cable for hauling the dump cars is driven from the northeast corner of the wharf. The stack of the power house is shown in Fig. 1. On the dock the cable overlaps, which makes it necessary to release the grip on the dump cars and regrip them after the overlap has been passed.

The method of working the system is substantially as follows: The barge loaded with coal is moored where the outboard extension of the bridge will be immediately above the hatchway. The bucket carriage is run out and the bucket dropped upon the coal to secure its load, as shown in Fig. 3. The bucket is then hoisted above the elevated tramway level, and before the hoist is completed the operator begins to run the carriage inwards toward the pier to save time. The bucket is brought to the

rear of the tower and its load discharged into a hopper located immediately over the tramway, as shown in Fig. 2. The transfer from barge to hopper goes on with but little regard to the operation of the tram cars; but of course this could not continue long. It seems to be the usual practice to shift the barge so that hatchway after hatchway comes into place instead of moving the bridge. On the tramway, a man will board an empty tram at the rear as it nears the bridge and release by means of the handwheel the grip which grasps the cable. The car is brought to a stop beneath the hopper and filled with coal, after which the grip will be tightened, but on the other section of the overlap, and the car despatched. The cars are operated at intervals of about 220 feet. The grip man who sends the car on, is able to know the moment the grip should be tightened by noting the position of the car next ahead.

Each car has a capacity of about 2½ tons of bituminous coal. The discharge of the load is accomplished by means of a block temporarily secured to the tramway at the desired points. This block trips the device that opens or shuts simultaneously the two side gates of the car. However, it seems to be considered advisable to have a man stationed near the point of unloading to see that all is well.

The coal drops down either side of the track, falling to the yard below. There is no stoppage of the car and sometimes a lump of coal will wedge into one of the discharge openings and hold both gates open. This situation calls for a workman's services.

Fig. 4. Tram Car Automatically Discharging Without Stopping

Fig. 5. Traveling Crane With 100-Foot Boom

In the rear storage yard the coal is stacked in the four great parallel piles that were shown on the January front cover of The Colliery Engineer. In these piles coal is stored to the height of 35 feet above the yard surface.

In order to command the storage space north and south of the 900 feet of straightaway double track, two immense locomotive cranes are installed on a broad-gauge track paralleling the straightaway both to the north and south. The broad track swings around the cable car loop at the west end of the yard on a radius of 100 feet.

These cranes are probably the largest and fastest machines of their kind that have ever been built, and a description of them will, therefore, be of interest. Each crane is of the traveling, revolving type, and is equipped with a clam-shell bucket of 3½ tons capacity in coal. The crane operates this bucket at a fixed radius of 100 feet so that each crane commands a width of storage area of twice its radius, or 200 feet. The lower frame of the crane, shown in Fig. 5, is 20 feet square and each of its four corners is carried on a four-wheel universally swiveling truck, which runs on a track having a gauge of 30 inches. The machinery for operating the clam-shell bucket is mounted on the revolving upper frame and is completely inclosed by a machinery house, on top of which is mounted the operator's cabin. Only one operator is required to control the various motions of hoisting the bucket, swinging, or traveling the entire machine along its track. Each crane was designed to have a handling capacity from dumping pile to storage area, or from storage area to cable cars, of 200 tons per hour. The tests made by the Edison company show an actual handling capacity of 240 tons per hour. The delivery of coal from the storage area commanded by the crane to the cable-car system is effected through a traveling hopper carried on the dumping trestle under which the cable cars pass to receive their load. After the cable cars are loaded from this hopper, they travel to the dock front, where they dump their load into a hopper located beneath the cable car trestle, from which the coal is delivered to the river barges by means of an inclined elevator and chute.

The additional storage yard which is in course of construction will duplicate the present arrangements. However, the crane track of the new yard will be connected with the

crane track of the present yard; so that it will be possible for cranes to go from one yard to the other. The curve making the connection will be just a little back from the water front. The tram cableway will have a long loop on the water front end. The two tramways will probably be operated entirely independent of each other. The long loop brings the tramway far enough south on the water front to put it within operating reach of the stationary tower.

When the new addition goes into service, the Edison company will then be able to store about a 6 months' supply, as present yearly consumption amounts to about 600,000 tons. The plant was installed by the Link-Belt Co. In order to provide for handling large quantities of coal, the company installed a lighting equipment which makes possible night operation.

The installation of an effective lighting system in a coal-storage plant is no simple matter, and the Edison people seem to have had difficulties. One of the principal problems related to the illumination of the cab and bucket of the locomotive cranes.

As the cranes and their buckets must cover the whole area and the whole vertical distance, no system of suspended lights appeared to be economically practicable because of the wide spans involved and the great volume of space concerned. Some searchlight system is indicated for the bucket by the general conditions. What was ultimately done was to install two lights on either crane, so arranged on the roof of the cab that a concentrated field of light 360 degrees in projection of a width equal to the maximum swing and elevation of the boom of the bucket is provided. In this field of illumination the operator can observe the opening or closing of the bucket jaws, 100 feet away, the movement of the derrick arm, and can load or unload the coal with the same facility as by daylight. Another problem consisted in providing a source of energy to run the search lights and the small lights in the cab. A flexible connection seemed inadvisable, because of conditions at grade due to the coal. A shoe contact was out of the question as all possibility of ignition had to be eliminated. Ultimately, an electric generator was installed on board each crane. The generator is driven by a steam turbine engine which receives its steam supply from the same source that supplies steam for the bucket engine. The generator which has a capacity of 1 kilowatt, occupies only 14 in. × 36 in. of floor space, weighs 400 pounds, and with the assistance of its automatic governor operates at a constant speed of 4,000 revolutions per minute with the steam pressure varying anywhere from 75 to 250 pounds per square inch.

The illumination, however, had to go further than simply dealing with the immediate points of activity. So the company has installed a general lighting system using towers scattered around the outskirts of the rear storage yard. The towers are 40 feet high and are arranged at intervals of 160 feet. The lamps have a candlepower of 1,000, and are of the kind known as the "point source of light"; the incandescence of the filament occurs in an atmosphere of nitrogen gas. A porcelain enameled steel reflector projects the light to the desired place and the design of the housing has made them spray-proof and has cared for the circulation of air necessary with units of this kind.

The superintendent in charge of the plant deals with a fire in a coal pile by digging it out. I scarcely think he has any faith in the application of water. Fortunately, the constant and large demand for coal at the generating plant makes it possible to dig out an infected pile and despatch the coal to the point of consumption. The steel linings of the wooden cable cars are for the purpose of protecting them from the hot coal thus in course of being transferred. In short, infected coal is gotten away from the plant at once. Apparently, no substantial trouble is experienced by the barges in carrying hot coal the 15 miles which separates the storage yard from the generating station.

The system of purchasing coal employed by the New York Edison Co. is also of interest. Generally, the coal is bought on railroad cars at the mines. The company then takes charge of the rail shipment and follows the coal from mine to tidewater. The advantage in this is that the company is not embarrassed in case of delays in transit by becoming one of a triangle, and has the manifest right of looking to the railroad directly. It is said that this system always enables the company "to know a week or two earlier than it otherwise would, that the coal is on the way."

The shipments are consigned in such a way as to distinguish the mine or group of mines from which the coal comes, so that at tidewater it can be promptly identified. As demurrage charges begin after a short time, the company must be prepared to get its coal away with a good deal of promptness. Accordingly, it maintains a fleet of barges. In the summer, the number will be around 20; in the winter, around 25. Their capacities vary from 500 to 1,400 tons, the average being about 1,000 tons. They are not owned by the company, but rented at an agreed-upon price per day. The policy is being pursued of replacing the smaller boats by larger ones of the self-trimming type. These shorten the time of unloading and reduce the expense. The individual barges are despatched to the generating station or to the storage yard, in accordance with conditions existing at the time. Care is taken that coal from different sources is not mixed when loading into a barge. The Shadyside storage yard is at present able to receive coal at the rate of about one average barge per day of 9 hours. When the new yard goes into service, this capacity will be doubled. The present plant can load out about three barges per day; the extended one will be able to load out about five barges.

Methods of Adjusting Mining Rates

With Special Reference to the Pittsburg District—Conditions Under Which the Present Rate is Unbalanced

By Leo Gluck, E. M.

In the present mining scale, according to the schedule of the Mine Workers and Operators Agreement, for the Pittsburg district, for all types of machine mining and pick work, to convert lump prices into run-of-mine prices, the lump prices are multiplied by .6464; conversely, run-of-mine prices are converted into lump prices by dividing by .6464.

This acknowledges that 64.64 per cent. of lump or 35.36 per cent. of screenings is the basing point of the mining scale. That is, with 64.64 per cent. of lump as a base, the number of tons of mine-run coal to be handled to get 1 ton of lump coal, either by machine or pick must be $\frac{1}{.6464}$ or 1.547 tons; or in other words for the lump price paid per ton, the operator has a right to expect .547 ton of screenings with the 1 ton of lump coal paid for. The present mining scale, while just in intent, is unbalanced as shown by the following:

If the miner sent out 1 ton of screenings on the lump basis he would receive no compensation, while the operator would receive 1 ton of screenings for the market; on the other hand, if the miner sent out 1 ton of coal which was entirely lump coal, he would receive compensation for 1 ton of coal handled, whereas according to the agreement intent for the same compensation he should have handled 1.547 tons of run of mine; which shows that the miner, here, is overcompensated, which is a loss to the operator; besides equivalently, the operator is short .547 ton of screenings for the market. Considering the two extremes as noted, it is only at the basing point that the present scale prices are correct and just to both parties of the agreement.

By changing to the mine-run basis, the intent of the agreement from the miners' standpoint is entirely fulfilled; but only at the basing point or 64.64 per cent. of lump in the run-of-mine coal is the agreement intent fulfilled with the operator.

In the mining of coal by pick and machine work, the screenings are not kept separate as pick screenings and machine screenings, so that no definite knowledge in the past was available to the miner or the operator of the amount of lump coal or screenings that was made by either the pick or machine separately. The operators and the miners took the average per cent. of lump and screenings made by the average per cent. of pick and machine over a long period as a representative condition of the quality of the coal; and evidently 64.64 per cent. of lump, or 35.36 per cent. of screenings was considered the basing point of the scale.

The basing point of the scale was considered equitable to both miner and operator, and, no doubt, in the ultimate it would represent the average condition. While it represents the ultimate average condition and satisfied both miner and operator, like all direct arithmetic averages, it has not eliminated the fact of overcompensation on one side and undercompensation on the other, but only truly compensates the average of all men at the total average condition.

In order to determine the true average per cent. of lump coal for all conditions, which has not been done before, due to the fact of not having available a method for such determination, the writer has developed a method as follows: By tabulating the percentage of pick and machine work and the corresponding lump or screenings made, the variation in the percentage of lump made with the variation of pick or machine is determined by graphical methods on coordinate paper by laying off the variation in pick horizontally and the percentage of lump or screenings as verticals, or ordinates, from which the true mean line can be determined fairly close. From the same data, by algebraical methods involving the method of least squares, an exact determination can be made of the percentage of lump coal made by machine work, and the per cent. of lump coal made by pick work for use in the general formulas.

With the knowledge of the lump coal made by machine-mined coal and the lump coal made by pick-mined coal, the present lump scale for machine and pick can be corrected in the mine-run basis so that the pick mining paid for run of mine and the machine mining paid for run of mine can have the true values determined from the tabulation of the variation in lump coal with variation of pick and machine; or from the run-of-mine basis pick work and machine work, respectively, the new lump pick rate and new lump machine rate can be calculated.

In the study of the relations of the functions that make up the machine and pick mining rates, the following characteristic symbols are used:

Pp = in decimals, the per cent. of pick-mined coal;

Mp = in decimals, the per cent. of machine-mined coal;

Pr = the rate paid per ton, in dollars and decimals, for undercutting, drilling by hand, and loading screened lump coal mined by pick;

pr = the rate paid per ton, in dollars and decimals, for undercutting, drilling by hand, and loading mine-run coal mined by pick;

Mr = the rate paid per ton, in dollars and decimals, for screened lump coal mined by machine, for undercutting, drilling by hand, and loading;

mr = the rate paid per ton, in dollars and decimals, for mine-run coal mined by machine, for undercutting, drilling by hand, and loading;

Ps = in decimals, the per cent. of screenings in pick-mined coal;

Ms = in decimals, the per cent. of screenings in machine-mined coal;

Pl = in decimals, the per cent. of screened lump, in pick-mined coal;

Ml = in decimals, the per cent. of screened lump in machine-mined coal;

S = in decimals, the per cent. of screenings in combined pick and machine-mined coal;

L = in decimals, the per cent. of screened lump in combined pick and machine-mined coal;

C = the cost per ton, in dollars and decimals, for the mine run (paid on the screened-lump basis) with variable per cent. of pick and machine;

CL = the cost per ton, in dollars and decimals, for screened lump (paid on the screened-lump basis) with variable per cent. of pick and machine;

CRM = the cost per ton, in dollars and decimals, for mine-run coal (paid on the mine-run basis) with variable per cent. of pick and machine;

l = in decimals, the per cent. of screened lump in mine-run coal (paid on the mine-run basis) with variable per cent. of pick and machine;

s = in decimals, the per cent. of screenings in mine-run coal (paid on the mine-run basis) with variable per cent. of pick and machine;

VL = in dollars and decimals, the selling price per ton of screened lump coal;

VS = in dollars and decimals, the selling price per ton of screenings;

V = in dollars and decimals, the selling values in a ton of mine-run coal from screened sizes;

N = the number of tons and decimals of run-of-mine coal to be handled to produce 1 ton of lump.

The development of a general formula for the present rate scale is as follows:

$CL = Pp \times Pr + Mp \times Mr$;
$Mp = 1.00 - Pp$;
$CL = Pp \times Pr + (1.00 - Pp) \times Mr$;
$CL = Pp \times Pr + Mr - Pp \times Mr$;
$C = CL \times L$;
$C = [Pp\,(Pr - Mr) + Mr] \times L$, Formula 1;

$pr = Pr \times L$;
$mr = Mr \times L$;
$CRM = mr + (pr - mr) \times Pp$, Formula 2.

Substituting the data given in the agreement between operators and miners in formulas 1 and 2:

Cost per ton of mine run, paid on lump basis, thin vein mining.

Air Machine: $C = [\$.7368 + (\$1 - \$.7368) \times Pp] \times L$, or $[\$.7368 + \$.2632 \times Pp] \times L$.

Electric Machine: $C = [\$.6900 + (\$1 - \$.6900) \times Pp] \times L$, or $[\$.6900 + \$.3100 \times Pp] \times L$.

Cost per ton of mine run, paid on lump basis, thick vein mining:

Air Machine: $C = [\$.6380 + (\$.8680 - \$.6380) \times Pp] \times L$, or $[\$.6380 + \$.2300 \times Pp] \times L$.

Electric Machine: $C = [\$.6020 + (\$.8680 - \$.6020) \times Pp] \times L$, or $[\$.6020 + \$.2660 \times Pp] \times L$.

Cost per ton of mine run, paid on mine-run basis, thin vein mining:

Air Machine: $CRM = \$.4769 + (\$.6464 - \$.4769) \times Pp$, or $\$.4469 + \$.1695 \times Pp$.

Electric Machine: $CRM = \$.4467 + (\$.6464 - \$.4467) \times Pp$, or $\$.4467 + \$.1997 \times Pp$.

Cost per ton of mine run, paid on mine-run basis, thick vein mining.

Air Machine: $CRM = \$.4128 + (\$.5611 - \$.4128) \times Pp$, or $\$.4128 + \$.1483 \times Pp$.

Electric Machine: $CRM = \$.3896 + (\$.5611 - \$.3896) \times Pp$, or $\$.3896 + \$.1715 \times Pp$.

The following is a development of general formulas for a mining scale which recognizes a difference in lump coal made by machine work and by pick work:

$Mp = 1.00 - Pp$;
$L = Pp \times Pl + Mp \times Ml$;
$L = Pp \times Pl + (1.00 - Pp) \times Ml$;
$L = Ml - (Ml - Pl) \times Pp$, Formula 4;
$S = Pp \times Ps + Mp \times Ms$;
$S = Pp \times Ps + (1.00 - Pp) \times Ms$;
$S = Ms + (Ps - Ms) \times Pp$, Formula 5;
$C = Pp \times Pr \times Pl + Mp \times Mr \times Ml$;
$C = Pp \times Pr \times Pl + (1.00 - Pp) \times Mr \times Ml$;
$C = Mr \times Ml + (Pr \times Pl - Mr \times Ml) \times Pp$ Formula 6;

$mr = Mr \times Ml$;
$pr = Pr \times Pl$;
$CRM = mr + (pr - mr) \times Pp$, Formula 7;

$CL = \frac{C}{L}$;

$CL = \frac{Mr \times Ml + (Pr \times Pl - Mr \times Ml) \times Pp}{Ml - (Ml - Pl) \times Pp}$ Formula 8.

The development of a general formula for the selling values from a ton of run-of-mine coal from the screened sizes combined, is as follows:

$V = VS \times S + VL \times L$;
$S = 1.00 - L$;
$V = VS \times (1.00 - L) + VL \times L$;
$V = VS - VS \times L + VL \times L$;
$V = VS + (VL - VS) \times L$, Formula 9;
$V = VS + (VL - VS) \times [Ml - (Ml - Pl) \times Pp]$, Formula 10;
$N = \frac{1}{L}$, Formula 11.

ALGEBRAIC METHOD, INVOLVING APPLICATION OF METHOD OF LEAST SQUARES TO DETERMINE VARIATION OF SCREENINGS WITH VARIATION OF PICK WORK

(Assumed Data) (Calculated)

Per Cent. Pick, Decimals	Per Cent. Screenings	A Pick Residuals From .30	B Screening Residuals From .3498	A Squared	A × B
.20	.3421	−.10	−.0077	.0100	.000770
.26	.3462	−.04	−.0036	.0016	.000144
.34	.3533	+.04	+.0035	.0016	.000140
.40	.3576	+.10	+.0078	.0100	.000780
Total 1.20	1.3992	.00	.0000	.0232	.001834
Average .30	.3498				

$\frac{A \times B}{A \text{ squared}} = \frac{.001834}{.0232} = .000791$ total variation with variation of .01 of pick, or the

Average of 30 per cent. pick = 34.98 per cent. screenings average.

An increase of .01 of pick adds .000791 of screenings, then for 100 per cent. pick = 40.52 per cent. screenings.

A decrease of .01 of pick, means increase of .01 of machine, subtracts .000791 of screenings, or 0 per cent. pick being 100 per cent. machine = 32.61 per cent. screenings.

Per Cent. Pick	Per Cent. Screenings	Calculated Screenings To True Average	Difference Between Observed and Calculated
.20	.3421	.3419	−.0002
.26	.3462	.3467	+.0005
.34	.3533	.3530	−.0003
.40	.3576	.3577	+.0001
Totals 1.20	1.3992	1.3993	
Average .30	.3498	.3498	

From the assumed data for machine-work lump and pick-work lump:

$Ml = .6739$, then $Ms = .3261$;
$Pl = .5948$, then $Ps = .4052$.

By formula 4, $L = .6739 - .0971 \times Pp$.

By formula 5, $S = .3261 + .0791 \times Pp$.

Problem 1.—Required at what per cent. of pick is the cost of mine-run coal the same whether paid on lump basis or run-of-mine basis?

AGREEMENT BETWEEN THE PITTSBURG DISTRICT COAL OPERATORS AND THE UNITED MINE WORKERS OF AMERICA GIVES THE FOLLOWING DATA

Cost Per Ton, Lump Basis	Air Machines		Electric		Pick	
	Thin	Thick	Thin	Thick	Thin	Thick
Undercutting in rooms	\$.1916	\$.1550	\$.1244	\$.1019		
Drilling by hand	.0300	.0240	.0300	.0240		
Loading in rooms	.5152	.4590	.5356	.4761		
	\$.7368	\$.6380	\$.6900	\$.6020	\$1.00	\$.8680

Cost Per Ton, Mine-Run Basis	Air Machines		Electric		Pick	
	Thin	Thick	Thin	Thick	Thin	Thick
Undercutting in rooms	\$.1239	\$.1002	\$.0805	\$.0659		
Drilling by hand	.0200	.0160	.0200	.0160		
Loading in rooms	.3330	.2966	.3462	.3077		
	\$.4769	\$.4128	\$.4467	\$.3896	\$.6464	\$.5611

Make $C=CRM$ and solve for Pp; $Pr=\$1$, $Mr=\$.69$.

By formula 6:

$C=\$.69\times.6739+(\$1\times.5948-\$.69\times.6739)\times Pp$;

$C=.4650+(.5948-.4650)\times Pp$;

$C=.4650+.1298\times Pp$.

By formula 7:

$CRM=.4460+.2004\times Pp$*.

Make $C=CRM$ in the formula and solve for Pp.

$.4650+.1298\ Pp=.4460+.2004\ Pp$;

$.0190=.0706\ Pp$;

$Pp=\dfrac{.0190}{.0706}=.2705$; or 27.05 per cent.

but $Mp=1.00-Pp$ or .7295, or 72.95 per cent.

From formula 4:

$L=.6739-(.6739-.5948)\times.2705=.6525$, or 65.25 per cent.

From formula 5:

$S=.3261+(.4052-.3261)\times.2705=.3475$, or 34.75 per cent.

Problem 2.—Required at what per cent. of pick is the lump .6464 on the basis of the mining scale?

By formula 4: $L=.6739-.0791\times Pp$.

Make $L=.6464$ and solve for Pp.

$.6464=.6739-.0791\times Pp$;

$\dfrac{.0275}{.0791}=Pp=.34766$ or say .3477, or 34.77 per cent. or when $Mp=.6523$, or 65.23 per cent.

Problem 3.—Required, per cent. of lump with 100 per cent. machine or at 0 per cent. pick.

By formula 4:

$L=.6739-.0791\times Pp$;

$L=.6739-.0791\times0=.6739$, or 67.39 per cent.

Problem 4.—Required, per cent. of lump with 0 per cent. machine, or at 100 per cent. pick.

$L=.6739-.0791\times Pp$;

$L=.6739-.0791\times1.00=.5948$, or 59.48 per cent.

Problem 5.—Required, number of tons run of mine to be handled to produce 1 ton of lump.

At 0 per cent. pick, or 100 per cent. machine when lump in run of mine = 67.39 per cent. it requires 1.483 tons.

At 34.77 per cent. pick, or 65.23 per cent. machine when lump in run of mine = 59.48 per cent. it requires 1.547 tons.

At 100 per cent. pick, or 0 per cent. machine when lump in run of mine = 59.48 per cent. it requires 1.681 tons.

The adjustment of the pick rate and the machine rate on the lump basis, and pick rate and machine rate on run-of-mine basis is as follows:

If the basis of work is 1.547 tons run of mine for 1 ton of lump at \$1 pick rate, then to handle 1.681 tons run of mine should be worth \$1.087 by the new lump pick rate.

In General.—Lump rate × per cent. of lump = mine-run rate. Then,

*Note.—This adjusts slight error in original scale.

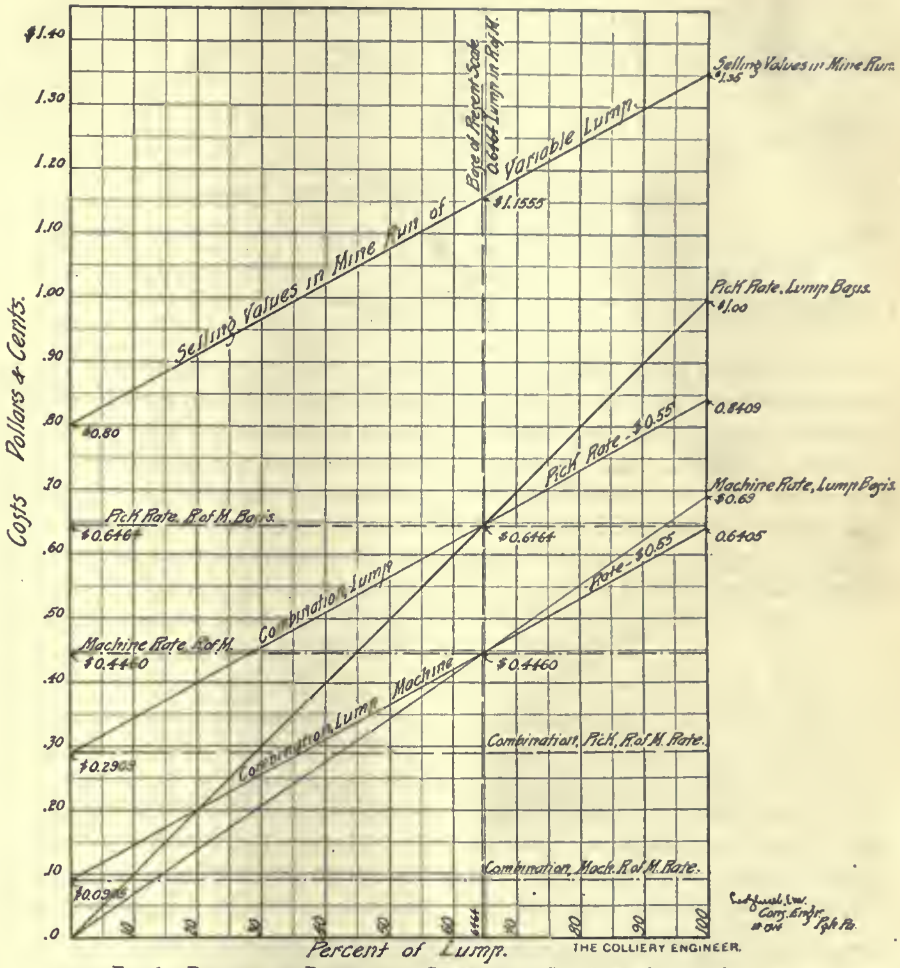


Fig. 1. Relation of Present and Combination Scale and Selling Values

$\$1.087\times.5948=\$.6465$ new run-of-mine pick rate.*

$\$\ .661\times.6739=\$.4458$ new run-of-mine machine rate.*

Substituting these new lump-rate values in formula 6:

$C=\$.4458+.2007\times Pp$;†

$C=\$.4458$ for all machine;†

$C=\$.6465$ for all pick.†

This proves that $C=CRM$ on the new scale rates, or that the cost by the new scale is the same for run of mine, whether paid for on the lump or run-of-mine basis, or that the pick and machine differential is by this method properly adjusted. The comparison is shown in the tables.

Cost of 1 Ton of Run of Mine on the Present Scale Basis

Basis	All Machine	At .2705 Pick	.3477 Pick	All Pick	Remarks
Lump	\$.4650	\$.5001	\$.5131	\$.5948	Present scale
Run of mine	.4460	.5002	.5157	.6464	Present scale
Difference	\$.0190	\$.0001	\$.0026	\$.0516	

Cost of 1 Ton of Run of Mine on the New Scale Rates

Basis	All Machine	At .2705 Pick	.3477 Pick	All Pick	Remarks
Lump	\$.4458	\$.5001	\$.5156	\$.6465	New scale
Run of mine	.4458	.5001	.5156	.6465	New scale
Difference	\$.0000	\$.0000	\$.0000	\$.0000	

Substituting these new run-of-mine rate values in formula 7:

$CRM=\$.4458+.2007\times Pp$;†

$CRM=\$.4458$ for all machine;†

$CRM=\$.6465$ for all pick.†

*Note.—.4458 should be .4460, .2007 to be .2004; .6465 to be .6464.

†Note.—.4458 should be .4460; .2007 be .2004; .6465 be .6464 to balance small error in original scale.

By adjusting the pick and machine differentials the present run-of-mine and the new run-of-mine scales remain unchanged but the new lump-basis scale becomes equal to the present run-of-mine scale. The machine rate is to be reduced and

Comparison of Run-of-Mine Basis—Present Scale and New Scale

Run-of-mine basis .... Run-of-mine basis	\$.4460 .4458	\$.5002 .5001	\$.5157 .5156	\$.6464 .6465	Present scale New scale
Difference, or practically.......	\$.0002 0	\$.0001 0	\$.0001 0	\$.0001 0	

Comparison of Lump Basis—Present Scale and New Scale

Lump basis............. Lump basis.............	\$.4650 .4458	\$.5001 .5001	\$.5131 .5156	\$.5948 .6465	Present scale New scale
Difference..............	\$.0192	\$.0000	\$.0025	\$.0517	

the pick rate is to be increased by the method outlined with the assumed figures to correct pick and machine differential; also if the Pittsburg district remains on a screened-lump basis this is the first natural step in equitable adjustment, and still maintain the basing point of the scale.

The original method, here shown, rigidly has always considered that pick work and machine work made the same percentage of lump coal in the product produced, but since it is a fact that pick work and machine work do not make the same percentage of lump, and therefore that the selling values of the product produced by machine and by pick are not the same, then the run-of-mine scale figured from the lump scale by multiplying by the fixed amount, or .6464, could not agree throughout, and only by changing the pick rates both on the lump and run-of-mine basis can they be made to agree and acknowledging the basing point of the original scale as being basically correct.

Taking the original scale and correcting the differential of pick and machine to the actual lump produced, it still leaves the lump-basis scale, that is, paying for lump only, as being correct only at the basing point. It is a known fact that changing from the lump basis to the run-of-mine basis always means a degradation of values in the run of mine produced, and, if the product is marketed as screened sizes, results in detriment to the operator.

In order to get a method of adjustment from the present, or modified scale, in which values in the product produced are considered, it means a method of double weighing and paying which can be done by Plan C as follows:

Method.—Weigh all the lump coal and pay for the same at a new price per ton; and also weigh the screenings that accompany the lump coal and pay for the same at its new price per ton.

The new price for lump coal per ton will be:

The old run-of-mine price plus .3536 of the differential between the selling price of lump and screenings per ton.

The new price per ton for screenings will be the old mine-run price minus .6464 of the differential between the selling price of lump and screenings per ton. This, Plan C, method of double weighing would be hardly practical and would mean expensive changes in the present old equipment, but could be used in newly designed equipment and become practical.

In order to take advantage of the present equipment with a minimum change of conditions, as well as of labor and expense, Plan D would be more practical, giving true equity throughout to both miner and operator.

Method.—Weigh the lump coal as at present, and pay for the same at a new price per ton, and weigh all the coal as run of mine and pay for the same at a new price per ton.

The price per ton for lump coal will be the differential between the selling price of lump coal and screenings per ton.

The new price for run of mine to be old mine-of-run price minus .6464 of the differential between the selling price of lump and screenings per ton.

The following shows the application of Plan D which shows the constant margin difference by the double weighing and paying method, where-

Comparison of Present Rates for Pick, and Machine, with New Pick and Machine Rates with Relation to Selling Values of the Screened Sizes Produced.
Thin Bed, Pick, and Electric Machine.

A—Present Scale	Assumed,
$Pr=\$1$, $pr=\$.6464$	VL at \$1.35;
$Mr=\$.69$, $mr=\$.4460$	VS at .80;
B—New Scale	$V=VS+(VL-VS)\times L$; but $L=.6464$ by present scale base;
$Pr=\$1.087$, $pr=\$.6464$	
$Mr=\$.661$, $mr=\$.4460$	$V=.80$ plus $(1.35-.80)\times .6464$ or \$1.1555.

Cost Per Ton of Run of Mine

	All Screenings		.6464 Lump		All Lump	
	A	*B*	*A*	*B*	*A*	*B*
Lump basis—pick................. Selling values.....................	\$.0000 .8000	\$.0000 .8000	\$ .6464 1.1555	\$ .7026 1.1555	\$1.0000 1.3500	\$1.0870 1.3500
Difference.........................	\$.8000	\$.8000	\$ .5091	\$ .4529	\$ .3500	\$ .2630
Run-of-mine basis—pick........... Selling values.....................	\$.6464 .8000	\$.6464 .8000	\$ .6464 1.1555	\$ .6464 1.1555	\$ .6464 1.3500	\$ .6464 1.3500
Difference.........................	\$.1536	\$.1536	\$ .5091	\$ .5091	\$ .7036	\$ .7036
Lump basis—machine.............. Selling values.....................	\$.0000 .8000	\$.0000 .8000	\$ .4460 1.1555	.4273 1.1555	\$ .6900 1.3500	\$ .6464 1.3500
Difference.........................	\$.8000	\$.8000	\$ .7095	\$ .7382	\$ .6600	\$ .7036
Run-of-mine basis—machine........ Selling values.....................	\$.4460 .8000	\$.4460 .8000	\$ .4460 1.1555	\$ .4460 1.1555	\$ .4460 1.3500	\$ .4460 1.3500
Difference.........................	\$.3540	\$.3540	\$ .7095	\$ .7095	\$ .9040	\$ .9040

Note.—Assumes no excess of screenings due to change to run-of-mine basis.

by the miner and operator both gain or lose equally. This method demonstrates a just run-of-mine combination method as it considers values in the product.

Plan D had considered only the right base of the present scale connected with the selling values of the product produced.

A general mining scale, which considers the selling values of the product produced and also defines the scale by a knowledge of the lump coal made by pick work and the lump coal made by machine work is determined by a method of weighing the run of mine separately and the lump separately and paying for each at rates given in the table below.

Pick Rates.—Pick lump price to be the differential between the selling values of lump coal and screenings per ton.

Pick run-of-mine price to be the old pick run-of-mine price minus the differential between the selling values of lump coal and screenings per ton multiplied by the per cent. of lump made by pick work.

Machine Rates.—Machine lump price to be the differential between the selling values of the lump coal and screenings per ton.

Machine run-of-mine price to be the old machine run-of-mine price minus the differential between the selling values of lump coal and screenings per ton multiplied by the per cent. of lump coal made by machine work.

Charts Nos. 1 and 2 graphically illustrate the method by applying the assumed data or fictitious figures used in this article.

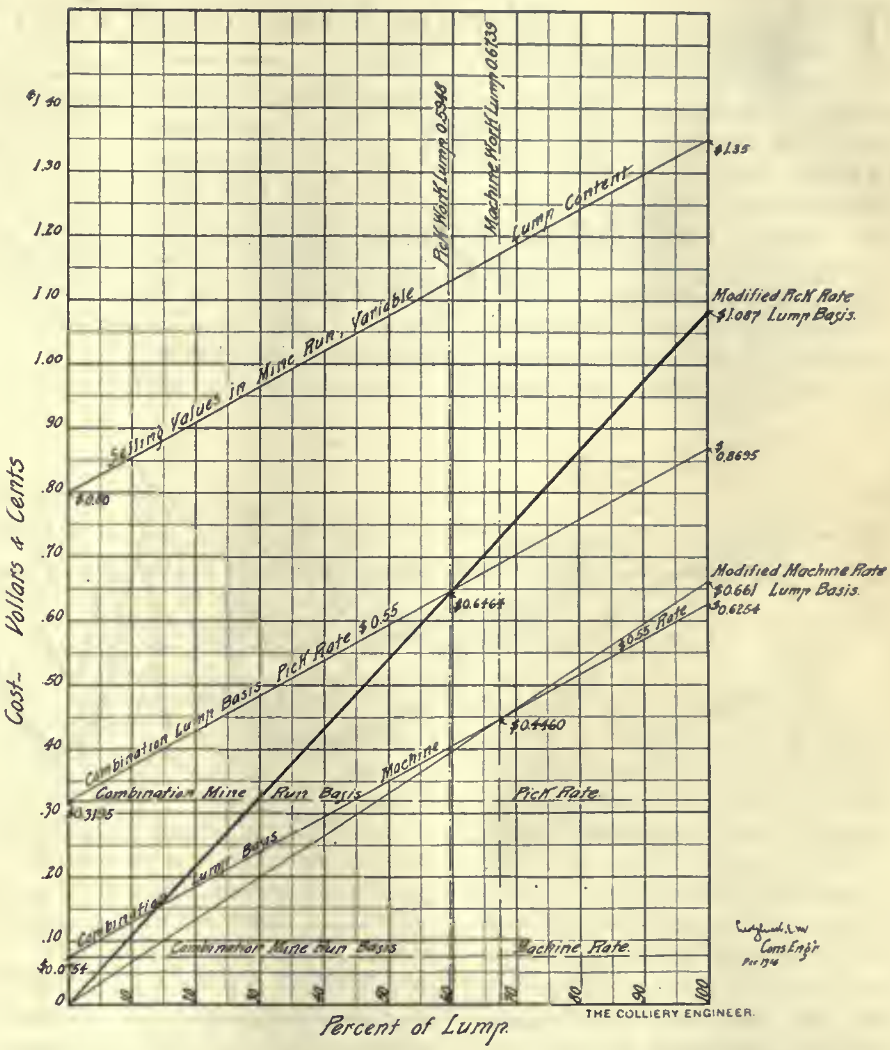


Fig. 2. Relation of Modified and Combination Scale and Selling Values

Rates for Making General Mining Scale

Assumed Selling Prices	Plan A	Plan B	Plan D
V at $1.1555.........	*Pr* at $1.00	*Pr* at $1.0870	*Pr* at $VL-VS=\$.55$
VS at .8000.........	*Mr* at .69	*Mr* at .6610	*Mr* at $VL-VS=.55$
Vl at 1.3500.........	*pr* at .6464	*pr* at .6464	*pr* at $.6464-.6464\times.55=\$.2909$
	mr at .4460	*mr* at .4460	*mr* at $.4460-.6464\times.55=\$.0905$

Cost Per Ton of Run of Mine

	All Screenings	.6464 Lump	All Lump
Cost of lump by pick...	$.0000	$ .3555	$ .5500
Cost of R. of M. by pick	.2909	.2909	.2909
Cost total by pick...	$.2909	$ .6464	$ .8409
Selling values..........	$.8000	$1.1555	$1.3500
Margin difference ...	$.5091	$ .5091	$ .5091
Cost of lump by machine...............	$.0000	$ .3555	$ .5500
Cost of R. of M. by machine............	.0905	.0905	.0905
Cost total by machine............	$.0905	$ .4460	$.6405
Selling values...........	.8000	1.1555	1.3500
Margin difference....	$.7095	$ .7095	$ .7095

News print paper has been made by the Forest Service laboratory from 24 different woods, and a number compare favorably with standard spruce pulp paper.

International Engineering Congress, 1915

It has been decided by the governing body of the American Institute of Electrical Engineers to indefinitely postpone the holding of the Electrical Congress. This does not affect the International Engineering Congress, which will be held as originally planned, September 20-25, in San Francisco, Calif.

The Committee of Management of the Congress wishes the support of the whole engineering fraternity, and feels that the volumes which will be received by those who subscribe to the Congress will be a very adequate return for the subscription fee. Full information concerning the Congress may be obtained by writing to the International Engineering Congress, 1915, Foxcroft Building, San Francisco, Calif.

Mining Steep Thick Coal Beds

Methods in Use by the Lehigh Coal & Navigation Co. in the Panther Creek Valley

*By W. G. Whildin**

THIS paper describes the methods of mining thick coal beds in use by the Lehigh Coal & Navigation Co. in the Panther Creek Valley, Pa. Typical cross-sections of the coal basin are shown in Figs. 1, 2, and 3.

The Mammoth coal bed varies in thickness. It is 21 feet at one colliery, from 50 to 125 feet at another,

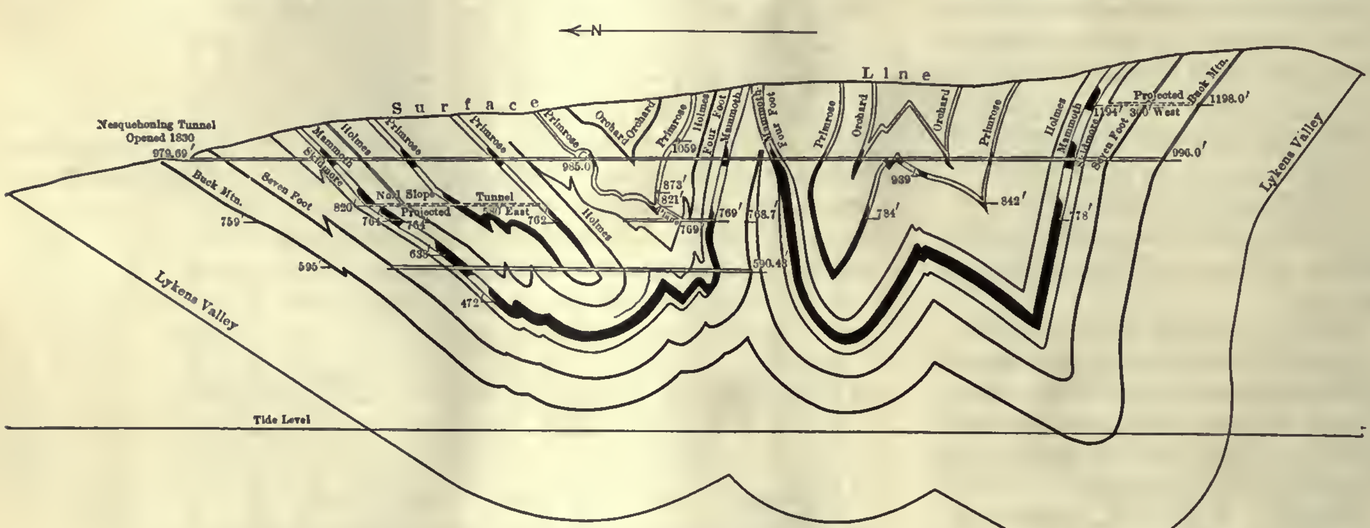


Fig. 1. Cross-Section of the Nesquehoning Tunnel

and over 200 feet at still another. Its normal thickness is from 35 to 40 feet.

At some points in the Panther Creek basin the Mammoth coal bed is in three splits—the Bottom, Middle, and Top, while in other portions the dividing strata between the coal benches are from 1½ to 2½ feet thick. The section of the Mammoth bed shown in Fig. 4 was taken at the Greenwood colliery, and shows a thickness of 60 feet. The miners know it by benches, as follows: The Three-Foot, the Four-Foot, the Eighteen-Inch Slate, the Bony, the Grey Slate, the Grain Clear, the Five-Foot, the Seven-Foot, the Slaty or Dirty benches, the Blue Slate, and the Top bench.

The present-day methods of mining are outgrowths of the experiences of the last 100 years in this territory. The first attempt at mining, according to the company's maps, was made at Summit Hill in 1792, when open cuts and pits were made. Later the pillar-and-breast method was introduced.

Drifts, slopes, and shafts, according to the requirements and physical conditions, are now the main openings, from which the gangways (haulageways) and airways are driven along the strike, the gangways in the various beds being connected by tunnels through the intervening rock on the same level. The gangways and airways in thick beds are heavily timbered throughout. The sets of timber, consisting of a collar and two legs, are spaced 5 feet apart, and later, after the ground has settled, additional sets, called "liners" or "relief sets," are placed between, to relieve the strain on the original timbers, so that the result is a set of timber every 2½ feet.

The ordinary timbers, when of wood, are: Collar, 8 feet 6 inches long and 15 inches diameter; legs, each 9 feet long and 14 inches diameter, set on a batter of 3 inches to the foot. A section of the gangways in the clear, therefore, is 7 feet 6 inches in width at the top, 11 feet 9 inches in width at the top of the track, and 7 feet 6 inches high above the track.

The timber in the airways is from 10 to 12 inches diameter and the size of the opening in the clear is 5 feet in width at the top, 8 feet in width at the bottom, and 6 feet in height. A considerable amount of steel is used, the sizes being for gangways a 10-inch I beam, 25 pounds per foot, for collar, and 8-inch H columns, 34 pounds per foot, for legs; for airways, a 9-inch I beam, 21 pounds per foot, for collar, and 6-inch H columns, 23.8 pounds per foot, for legs. Some 6-inch H beams, 23.8 pounds per foot, are being tried for collars instead of the I beams, and so far are giving better results. Where wood is subject to dry rot the use of steel has been very successful, but where there is a constant squeezing or heaving it has been found inadvisable to substitute it for wood. A very considerable saving in timbering maintenance has been made to this time by the use of steel, and its use is being extended.

All turnouts and permanent openings, where timbering is necessary, are being supported with steel, and sections of various sizes up to 70 pounds per foot are used, according to the requirements. It is probable

*Abstract from a paper read at the Pottsville meeting of the anthracite section of the American Institute of Mining Engineers.

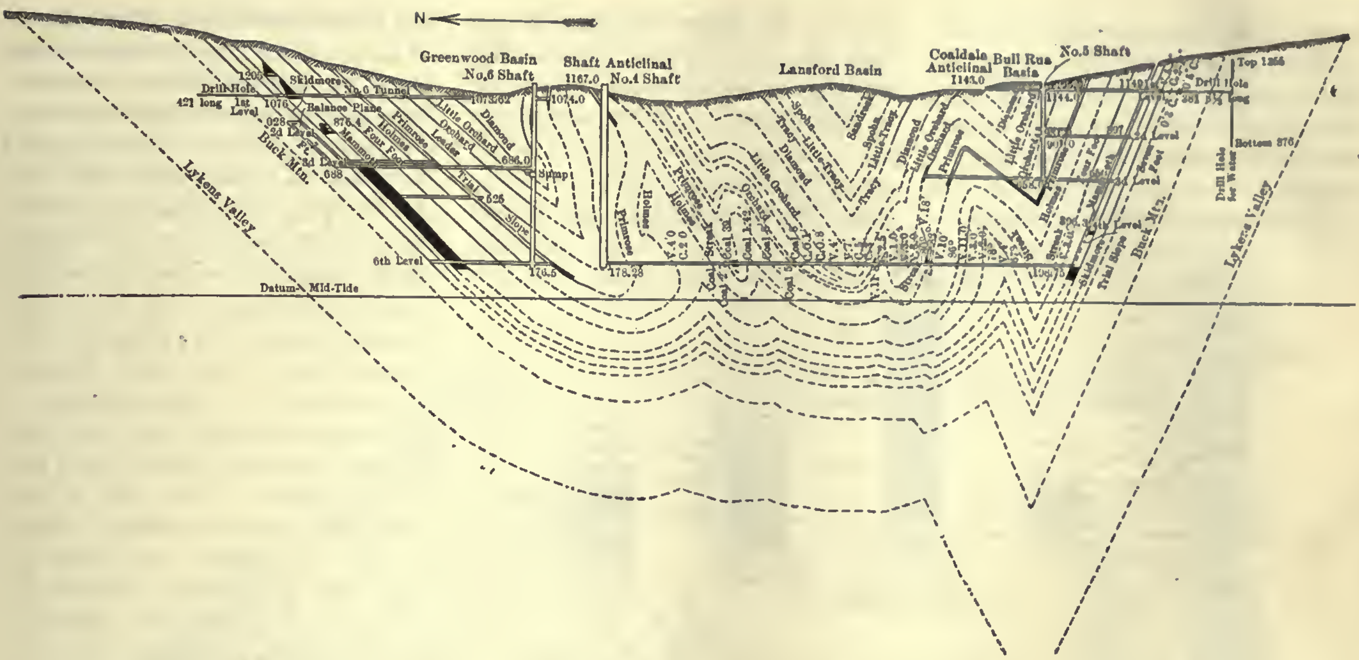


Fig. 2. Cross-Section Through Panther Creek Valley at Lansford Colliery on Line of Nos. 4, 5, and 6 Shafts

that the average life of a set of steel supports in a gangway will be at least 10 years. The average life of timber sets in a gangway is 3 years. In many instances timber has lasted 15 years, and in many others it has lasted less than 1 year, depending entirely upon the conditions. There are also many instances where it was almost physically impossible to hold open certain stretches of gangways until after steel supports had been installed.

Figuring the average life of timbers as 3 years, and steel sets as 10 years, the saving made by using steel will be fully 100 per cent.

A notable instance in the economy of using steel was shown in the case of a turnout which had to be retimbered every 9 months at a cost of $20 per set for labor and material, where steel costing $40 per set for labor and material is still sound. It will be seen from this that the saving amounts to more than $60 per set to the present time.

This company uses peeled timber, although at times it is unable to procure it. It is experimenting with steel supports that replaced wooden sets in a few main chutes, which will have to be held open for 5 or 6 years, and believes it will result in a saving.

The proper position of gangways and airways with reference to the top and bottom rocks is sometimes a problem. In beds pitching from 60 degrees to 90 degrees the gangways and airways are driven along the top rock, for the reason that the loading chutes can be driven back from the top rock to the bottom rock on about 30 degrees pitch, thus providing a safe working place for loaders, and also providing a means of controlling the loose coal. In beds with lesser pitches the gangways are driven on the bottom rock, and the airway along the top rock.

The distance between a gangway and its airway, when both are driven along the same rock, varies according to conditions. Years ago the distance was from 20 to 30 feet, but during the last few years it has

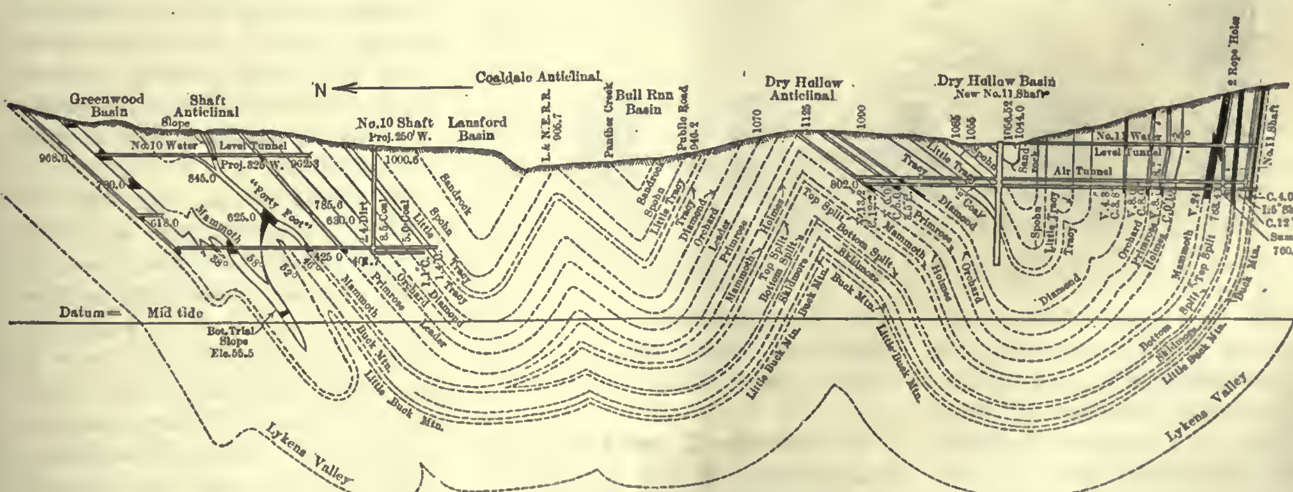


Fig. 3. Cross-Section Through Panther Creek Valley at Greenwood and Rahn Collieries on Line of Nos. 10 and 11 Shafts

been found advantageous in some cases to increase this distance to 50 feet in those sections where the chutes were driven on 60-foot centers as it results in a lower maintenance cost of the gangways.

The method of opening a breast is as follows (see Figs. 5 and 6): A chute, 6 ft. × 6 ft., partitioned to make a traveling way and a loading chute, is driven from the gangway on a pitch of 22 degrees until the bottom rock is met. It is then continued up the pitch of the bottom rock, to the height at which it has been decided to have the stump heading or bottom breast cross-cut. At this point a jugular battery is put in and a 4 ft. × 6 ft. cross-cut is driven connecting the top of the chute with the top of the next chute. This cross-cut which is used for ventilation and travel, is locally known as the "bottom breast cross-cut."

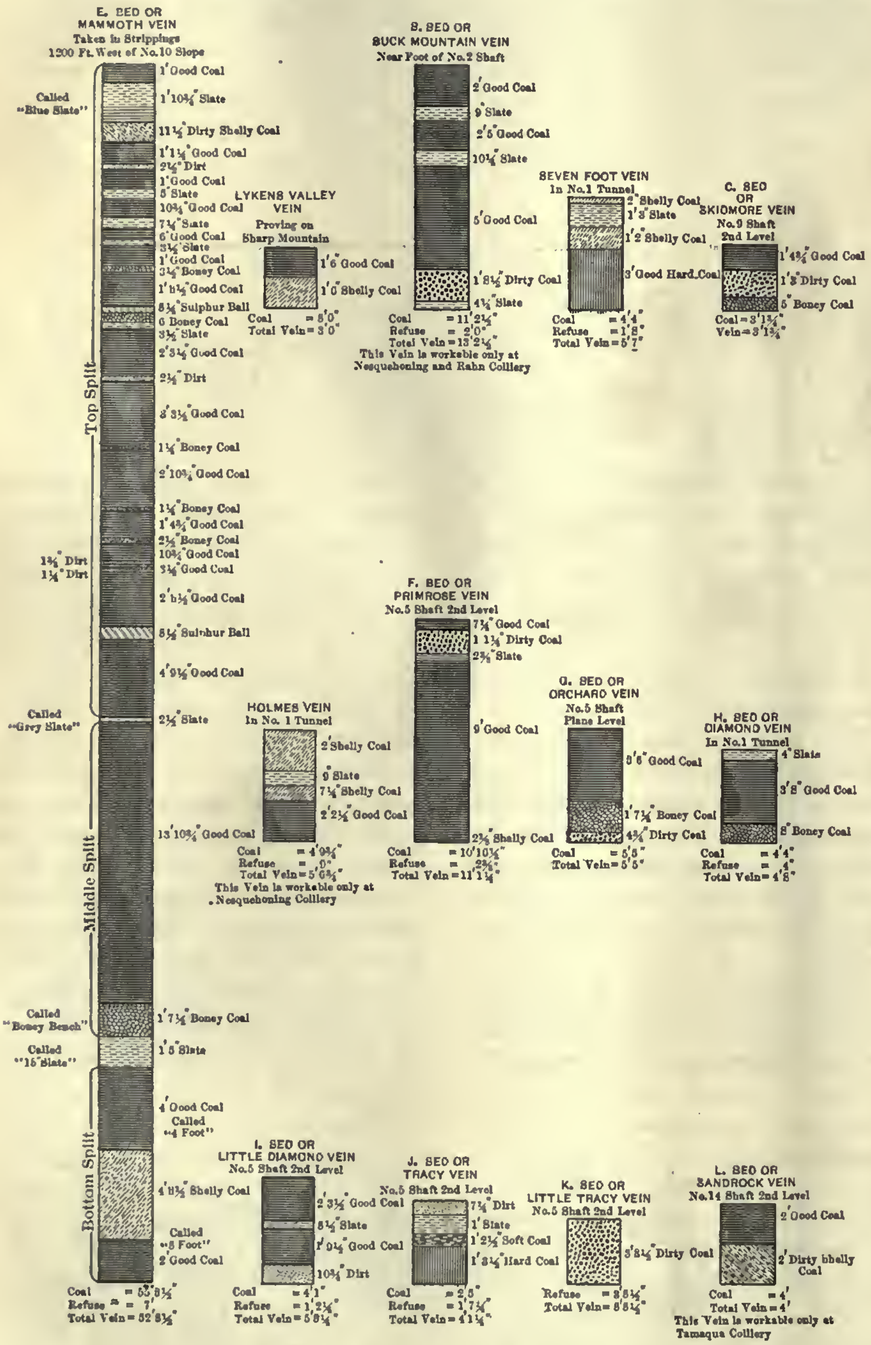


Fig. 4. Sections of the Coal Beds in the Panther Creek Valley

In forming a breast, the "front" manway or "dog hole" is driven on one side about 20 feet up the pitch and a back manway is driven parallel on the other side; both these start from the bottom breast cross-cut. The opening between the back manway and the battery jugular collar is 10 feet wide and 8 feet high, but this opening is gradually widened up the pitch until it reaches the top of the "dog hole," where the two are connected, forming what is called a "stump" above the battery. The breast is now 18 feet wide between the manways. A short manway is driven on top of the "dog hole," and the first cut-back is made in the following manner: The top of the "dog hole" forms the bottom of the cut-back; manways are carried on both sides and the coal blasted the 18 feet wide between the manways and 10 feet high until the top rock of the bed is reached. After the first cut-back has been completed, the breast is driven 30 feet farther up the pitch, where the second cut-back is made. The second and additional cut-backs are similar to the first. Where the pitch of the coal bed is 45 degrees, for instance, the loose coal does not fill the whole space excavated and the miners carry a "path" along each rib of the cut-back. Two miners blast the coal, each traveling his own path, until the top rock is reached and all the coal is taken out between the first and second cut-backs. The breast is again driven up the pitch 15 feet, where the third cut-back is made in the same way as the second. If the breast does not run away, or the top coal does not fall, a cut-back is made every 15 feet up to the old level. In steep pitching beds no paths are necessary, the miners standing on the loose coal to make the cut-backs.

It frequently happens that the coal in the breast runs away after the second or third cut-back is made, in which case a chute is driven along the back manway of the breast to a point about 30 or 40 feet above the face, where a battery is put in, and another breast is driven similar to the one described. If the coal in this breast runs, the chute is carried farther up the pitch and another

breast opened, probably reaching the old level above.

At one colliery where the coal bed is practically vertical and the breasts are driven along the bottom rock, the manways are driven along the top rock. This method has been found of great assistance, as the manways are not so liable to become blocked by falls and thus interfere with the ventilation of the breast.

Where the coal bed is split, a different method is used. At the Tamaqua colliery where there is a bottom and a middle split, the parting slate is from 12 to 18 feet thick. The bottom split is 7 feet thick and the middle split 4½ feet thick. The gangway is driven in the bottom split, as is also the airway, 40 feet above. Rock holes with 50-foot centers, are driven from the bottom-split airway to the middle split. The middle split is mined by breasts 8 yards wide, and the pillars robbed by skipping, beginning at the top. After the completion of the robbing, the bottom split is mined in the same way directly underneath the middle-split breasts. The cost of coal mined by this method is high, because two breasts have to be driven for 12 feet thickness of coal.

It was originally planned to use the breast method in the middle split and the chute method in the bottom split, the chutes being driven while the breast was being worked. Care was taken, however, that the robbing at the top of the chutes in the bottom split was not commenced until the robbing had been completed at the top of the breast in the middle split. It was found that as soon as the pillars were cut in the middle split there was so much squeezing and heaving in the chutes in the bottom split that it was almost impossible to hold them open, and the plan had to be abandoned. At the present time, breasts are being driven in both splits satisfactorily, except as to high cost.

Many years ago breasts were driven 10, 12, and 20 yards wide, and in the old Rhume Run tunnel of the Nesquehoning colliery some were driven 30 yards wide. At the present time breasts are driven 8 yards wide; and where the coal in the bed is apt to run, not more than 6 yards wide.

As the width of breasts has decreased, the width of the pillars between breasts has increased. For instance, where 12-yard breasts were driven on 50-foot centers, the pillars were 14 feet wide. At the present time 6-yard breasts driven on 50-foot centers have pillars 32 feet wide.

In thick beds, breast work is preferable to chute work, especially where there is a good supply of air, because the blasting necessary is much less, and consequently the yield of prepared sizes is more. This is due to the fact that after the first cut-back has been made there is a loose end. Very often the coal in a breast will run away after the second or third cut-back has been made, or sooner if the bed is shattered or slippy, and 2,000 or more

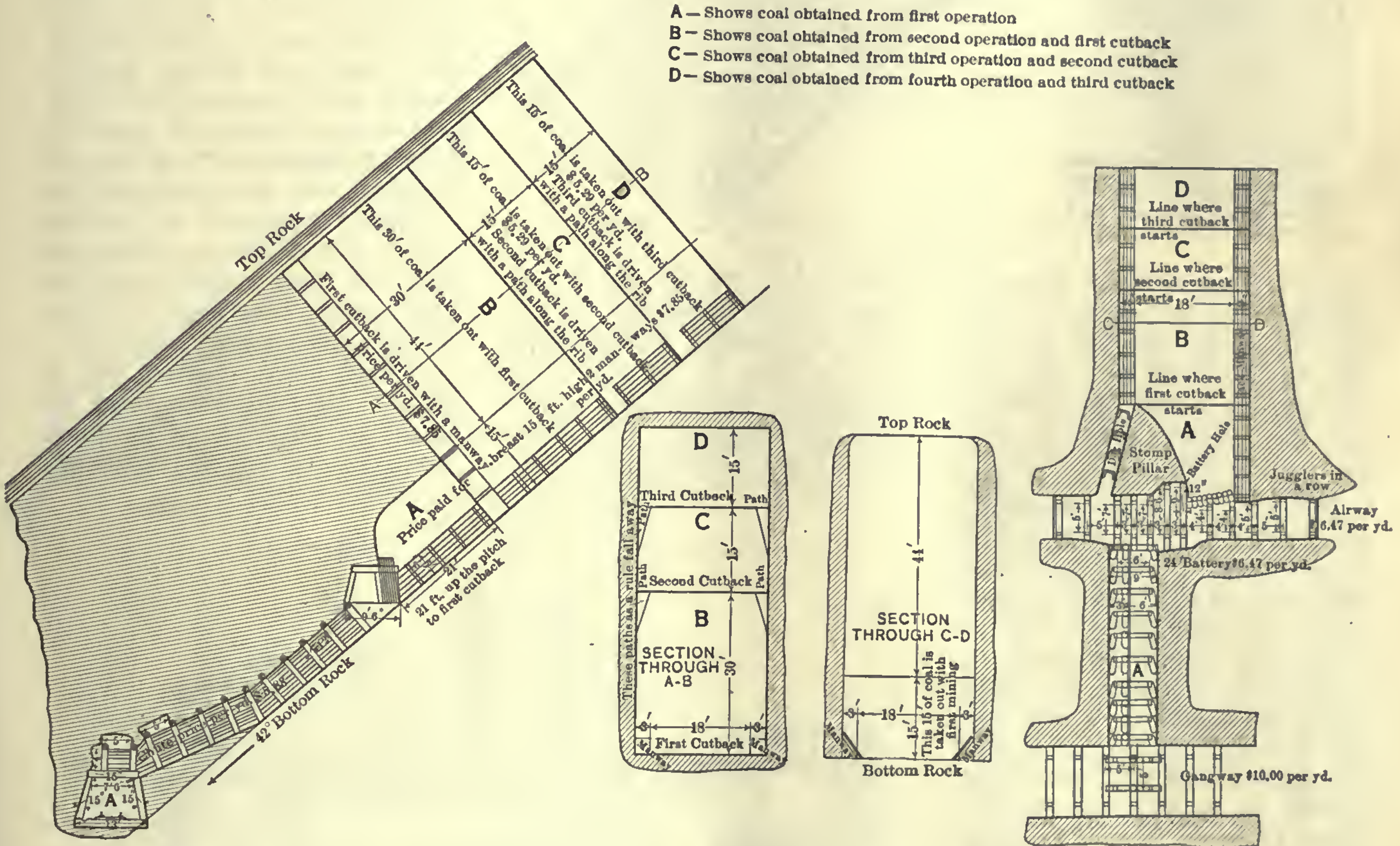


Fig. 5. Cut-Back in No. 62 Breast, East Mammoth Bed, No. 10 Shaft

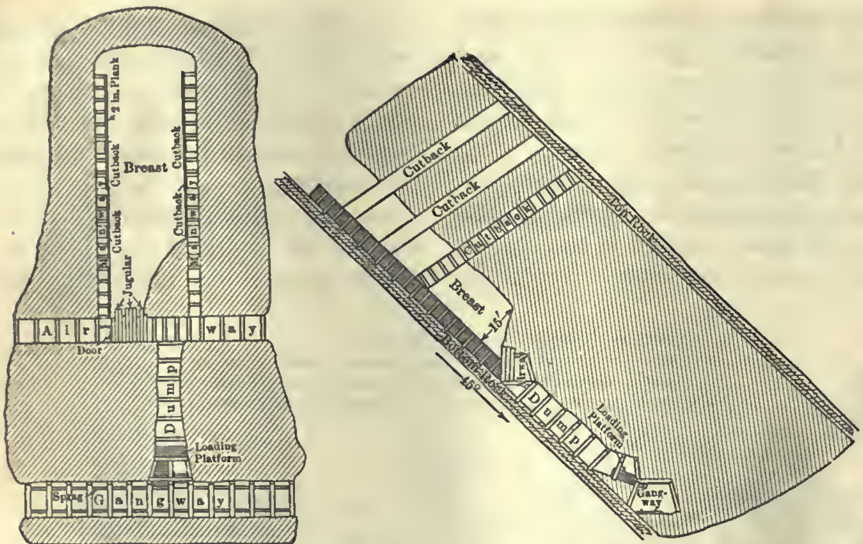


Fig. 6. Method of Working the Mammoth Bed, Lower Level, No. 8 Colliery

cars will be loaded out before the coal has run to the lift above. However, when the coal runs it always fills the breast with gas, until it has run through to the old workings; and this condition requires great care in order to avoid explosions.

In chute mining in new ground, the chutes are driven almost to the lift above, and so soon as the upper section of the chute breaks through to the old workings there is not much further trouble with gas.

The coal is mined by driving chutes back toward the top rock, where breasts are driven first along the top rock, and later up the pitch. Retreat is made down the main chute for from 30 to 50 feet and another chute is driven to the top rock, and the operation repeated. This method is carried on until the coal has been worked down to the lower level.

All the coal has to be blasted, as heavy falls cannot be expected on account of the shortness of the sections, and also because there are no loose ends. The maintenance cost of the chutes is very high. The result of a test made at one colliery from 1907 to 1909 showed that the breast method cost only 60 per cent. as much as the chute method. However, the recovery by the breast method was only 92 per cent. as much as by the chute method.

The most important question in mining, especially in so far as the ultimate yield of the bed is concerned, is robbing the pillars.

The early mining practice was to slice the pillar at the top of the "dog hole" and to bear into and cut it through if possible. It was mined up the pitch until it became too dangerous to go farther, or until the gob from the old breasts rushed in. By this method a large percentage of the pillar was left standing, as the heavy rock from the breast would soon rush in and the place would be abandoned.

A later method was, to drive a chute in the center of the pillar some distance up the pitch, where the pillar was cut through from breast to breast. A larger percentage of coal was obtained by this method, but it was soon found that the maintenance cost was high, due to the squeezing of the pillars, although it was more successful on the slight pitches than on the steep pitches. On the steep pitches the coal and rock coming down the chute knocked the timbers out, causing heavy maintenance charges.

Another former method was to couple up the old manways of the breasts on each side of the pillar and put in a battery (the old breasts

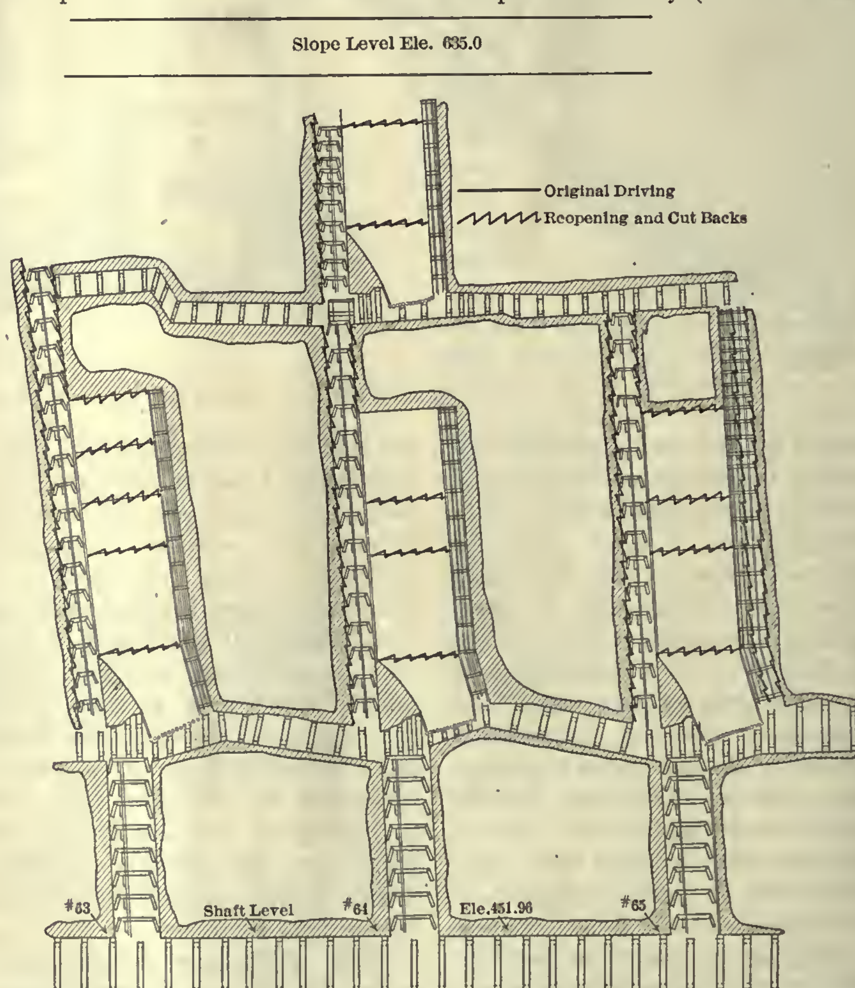


Fig. 7. Method of Working Breasts and Pillars, East Mammoth Shaft Level, Colliery No. 10

being left full of coal). The bottom benches were taken out between the manways and were cut back in the middle of the pillar toward the top rock, care being taken to leave a small pillar on each side above the old manways which had been coupled, in order not to break them. After these pillar breasts had been driven up to the same height as the face of the old breasts, loading was commenced from the three batteries, trusting that the small pillars over the manways would crush, and all of the coal would be won. This method was found objectionable, as the pillars squeezed so much that it became too dangerous for men to continue to work, and they were seldom able to drive the pillar breast as far as the face of the old breast.

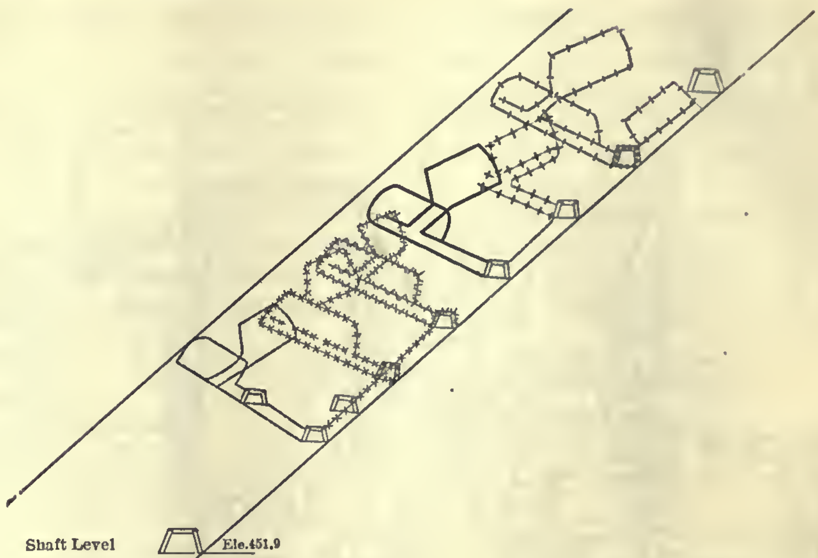


Fig. 9a. Section Through C–D of Fig. 9

The chute method of robbing pillars was then tried out. These chutes were driven about 25 feet apart and to within 30 feet of the old level above, and robbing was commenced at the top. It was first thought that by this method it would be easier to reach the coal between the chutes; however, it was soon noticed that so many openings caused such a general squeezing in the chutes that it was almost impossible to keep them open, and in fact many of them were lost. This distance between centers was then increased to 50 feet, and later to 60 feet. The main chutes were connected by slant chutes, which were used for ventilation and later for robbing the various blocks of coal in the pillar. This method is the present practice.

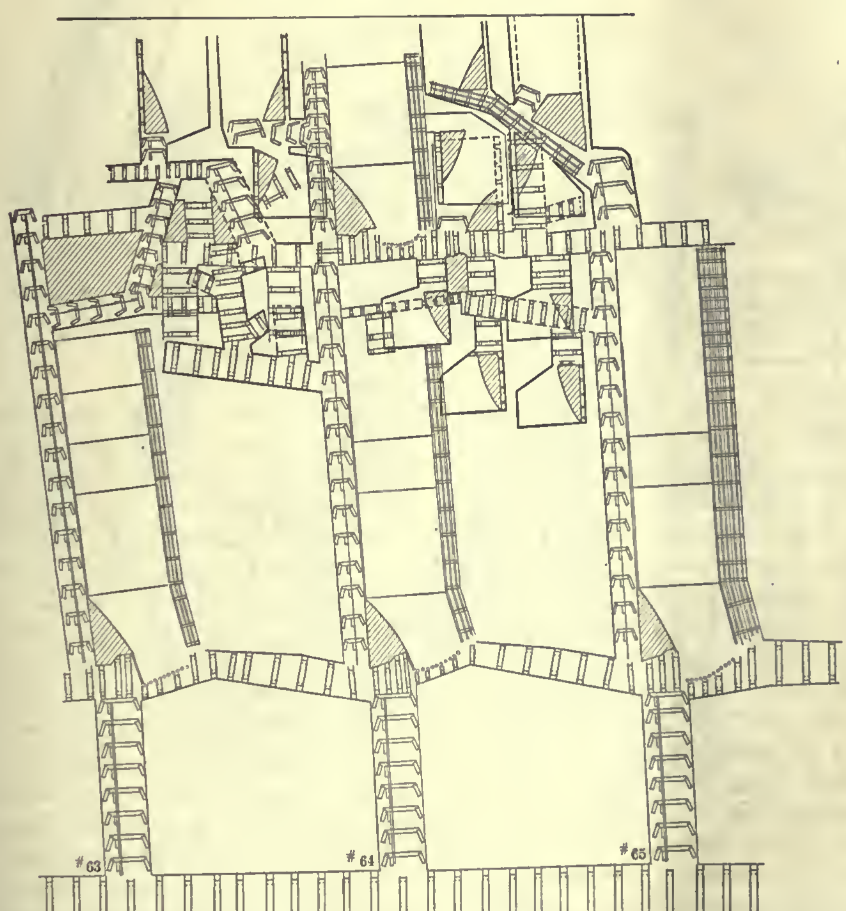


Fig. 8. Method of Working Breasts and Pillars, East Mammoth Shaft Level, Colliery No. 10

At the Greenwood colliery a record was kept of every step when driving two adjoining breasts and when robbing the pillar between (see Figs. 7 to 9), in order to determine what recovery was being made by the method in general use. At this place the bed was 59 feet thick and the breast 190 feet long. The total solid coal in this section was 590,000 cubic feet, or 8,260 mine cars of 125 cubic feet each. There were loaded out 5,442 mine cars, equivalent to 65.9 per cent. recovery. This work was done in 1909, 1910, 1911, and 1912.

The method of robbing the pillar was as follows: Chutes were first driven along the manways; slant chutes were driven across the pillars, and a chute driven back almost to the top rock. Then a breast was driven up the pitch and the coal mined. Chutes along the small pillars between this breast and the old breasts recovered that part of the coal. After all of the coal had been mined near the top rock, another breast was opened from the main

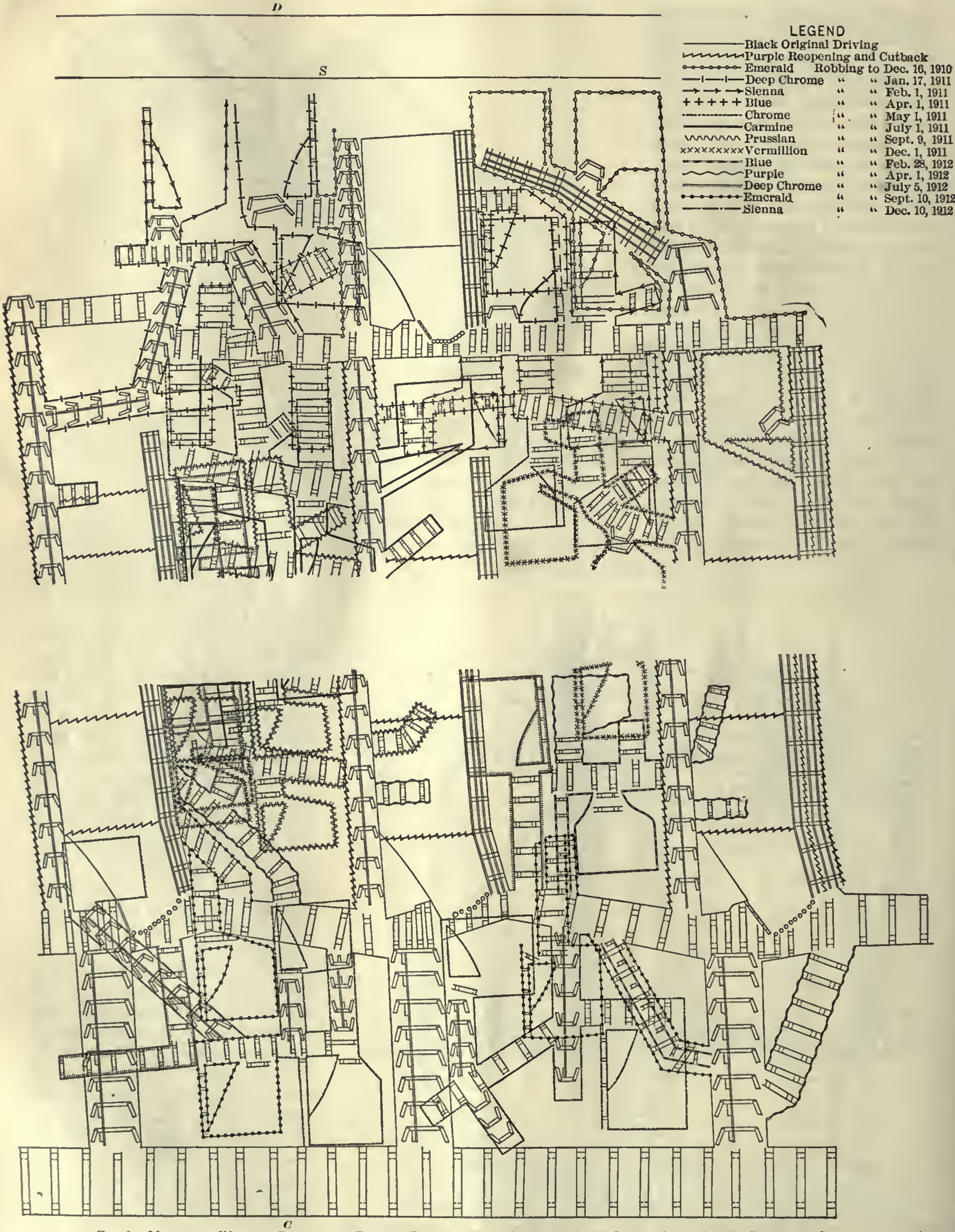


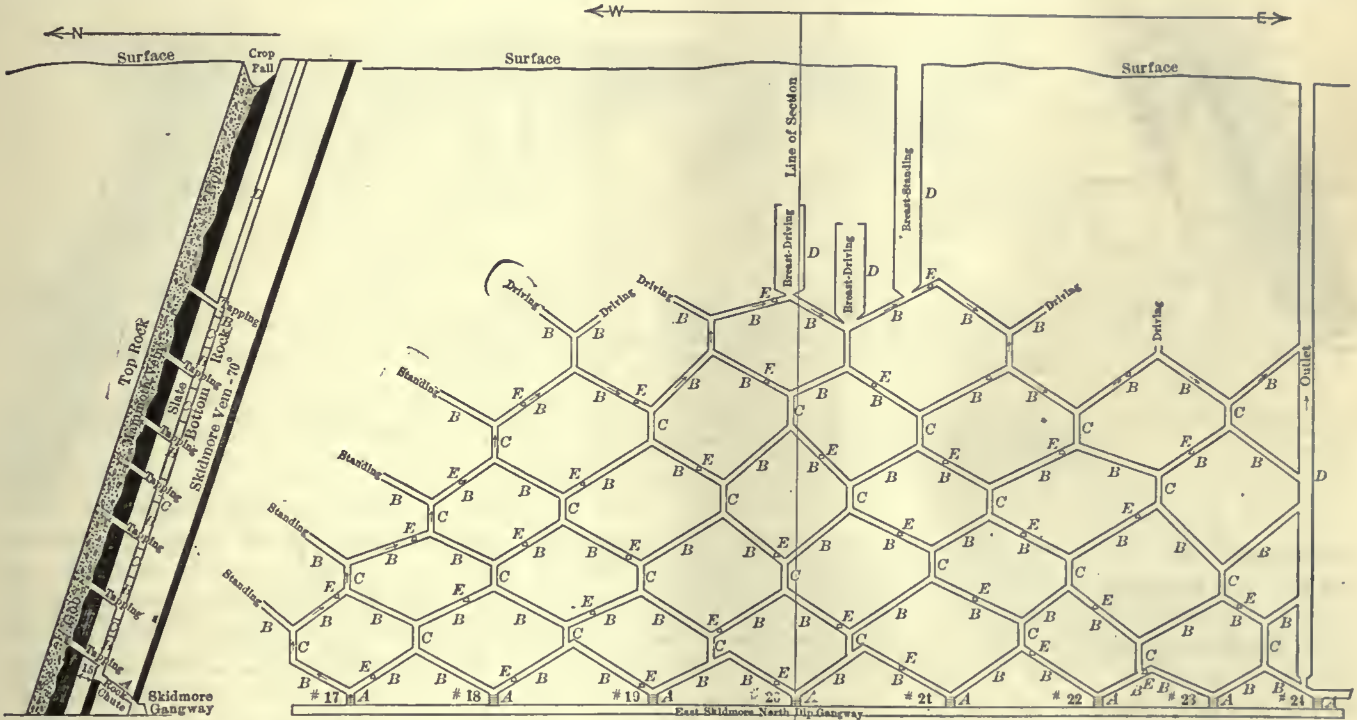
Fig. 9. Method of Working Breasts and Pillars, East Mammoth Gangway, Shaft Level, No. 10 Shaft, Greenwood Colliery

chute (driven back through the pillar), and later chutes were driven to mine the small pillars between the breast and the old breasts. When all of the coal possible had been mined in this way toward the top rock, a breast was driven on the pitch along the bottom rock. Again chutes were driven to mine the small pillars between this breast and the old breasts. After this was done the upper part of the pillar was supposed to have been robbed completely; then retreat was made down the chute 30 feet and a main chute driven back through the pillar, and the whole operation repeated.

The drawings show a network of chutes and breasts. It has been found by experience that, in order to recover a good percentage of the coal, where the bed is so thick, chutes must be driven in any and all small pillars that have been left between any of the breasts or chutes. In every case, however, the pillar being robbed must be controlled; it cannot be allowed to run away.

The reworking of old territory is always an interesting problem. Years ago it was the practice to reopen an old gangway, and as a rule the cost was heavy, especially if the ground had not been standing long enough to settle thoroughly. In some instances ground has settled in six or seven years, while in other instances ground has not settled in 15 years. The most satisfactory way to rework the old Mammoth territory has been to drive the gangways in the Skidmore bed and drive rock chutes to the Mammoth bed. At first these rock chutes were driven about 100 feet apart, but this distance has now been extended to 120 feet, 140 feet, and even 150 feet at one colliery. The rock chutes are connected at the top with slant chutes; then, about 10 feet off the rib of the rock chute, main chutes are driven straight up the pitch, and connected by slant chutes across the pitch. The slant chutes provide ventilation and also determine the location of any pillars which had not been worked. At several collieries where the pitch is almost vertical, a straight or box chute about 40 feet in length is driven up the pitch from the apex or meeting point of the two slant chutes (Fig. 10). At the top of the box chute two other slant chutes are driven, and again at their meeting points a box chute is put in. This is continued up the pitch to almost any distance desired, in many cases over 400 feet. This method has proved valuable and at all times the miners are safe.

As a rule this system of chutes is made in the bottom bench, which in most cases has been found solid; the reason being that the coal was extremely hard and could not be mined at a profit many years ago. At intervals, holes are driven through the 18-inch slate into the middle and top benches of the bed, and the gob from the old breasts is drawn out. Where the gob can be driven through, chutes are driven on a pitch of 30 degrees to 35 degrees into the top rock. A pitch of



Cross-Section through Chute No. 20

FIG. 10. METHOD OF WORKING BOTTOM AND MIDDLE SPLITS OF THE MAMMOTH BED, AS VIEWED AT RIGHT ANGLES TO THE PITCH. NO. 5 SHAFT, SECOND LEVEL, EAST SKIDMORE, NORTH DIP GANGWAY

A.—Rock chutes, Skidmore to bottom split of Mammoth. About 30 feet long on 35 degrees, 6 ft. × 8 ft. chute, 120-foot chutes. *B.*—Slant chutes on bottom rock of bottom split of Mammoth. About 70 or 80 feet long on 35 degrees, 6 ft. × 6 ft. chutes. *C.*—Straight chutes up the bottom rock of bottom split of Mammoth. About 20 feet long on 70 degrees, 5 ft. × 6 ft. chute. *D.*—Breasts on bottom rock of bottom split of Mammoth. About 160 feet long to surface on 70 degrees, 8-yard breast, 50-foot centers. *E.*—Tapping chutes from bottom split to middle split of Mammoth. Used as batteries for running coal.

35 degrees is not too steep through gob, as more rock has to be handled, and the gob is sticky or gummy. Where the bottom bench has been worked, it is necessary to do all of the opening work for robbing purposes in the gob. On the steep pitches the chutes are given an inclination of from 30 degrees to 35 degrees and driven along the strike Mammoth bed. These chutes were about 30 feet in length and on a pitch of 35 degrees. The Mammoth bed was worked according to the usual methods described. These Skidmore gangways required a great deal of repairing because of the very poor top rock at this colliery, and also the small distance between the chutes. liery (Fig. 11), where the coal is on a pitch of 72 degrees. The rock chutes are driven from the Skidmore gangway to the Mammoth, and from the top of these chutes long slant chutes—7-foot collar and 7-foot leg—on a pitch of 35 degrees are driven along the bottom slate of the Mammoth to the bottom of the old breaches on the surface. This

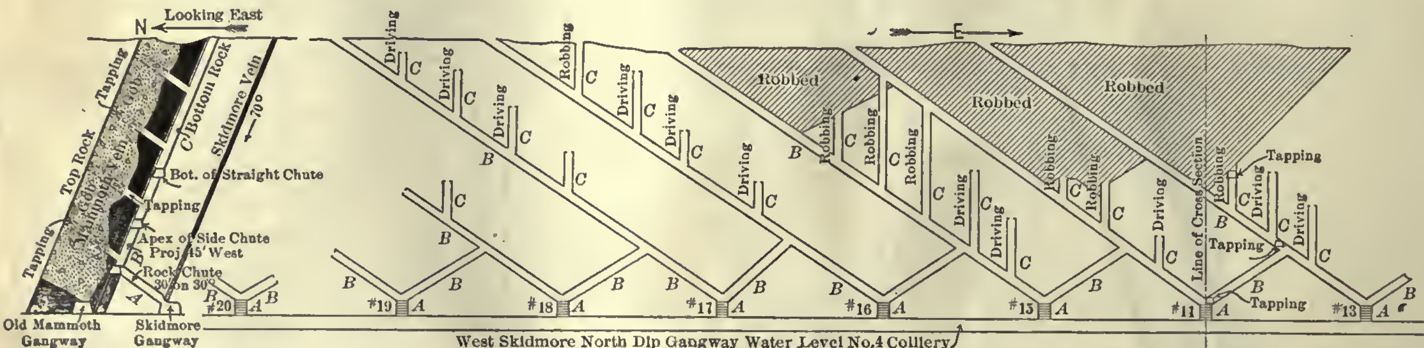


Fig. 11. Method of Working the Mammoth Bed, as Viewed at Right Angles to the Pitch. No. 4 Water Level, West Skidmore, North Dip Gangway

Cross-Section through Chute No. 14

A.—Rock chutes from Skidmore to Mammoth. 6 ft. × 8 ft. chute, 35 feet on 35 degrees, 100-foot centers. *B*.—Slant chutes on bottom rock of Mammoth. 7 ft. × 7 ft. chute on 35 degrees, 300 feet to surface. Side slants 55 feet long. *C*.—Straight chutes up on bottom rock of Mammoth. 5 ft. × 5 ft. chute, 60 to 100 feet long on 70 degrees. These chutes on about 35-foot centers, depending on condition of gob.

or else directly through the gob at right angles, for the reason that in the gob it is necessary to protect the roof of the chute by driving poles, 6 to 10 feet in length and 4 to 6 inches in thickness, ahead of the actual working face, to give full protection while placing the next set of timber.

It is readily seen that in loose ground, if the chutes were driven directly up the pitch on say 70 degrees, the poling process would be of no benefit, and miners would be in danger from falls of material.

In driving rock chutes from the Skidmore bed to the Mammoth the economical spacing of the rock chutes, due to the varying thickness of the rock between the two beds becomes problematic. Experience has shown that where the rock is 30 feet thick the chutes can be driven 100 feet apart; 40 feet thick, 120 feet apart; and 90 feet thick, 150 feet apart.

About 1891, when the fourth and fifth levels at the Coal Dale colliery were opened, the gangways were made in the Skidmore, and rock chutes driven every 50 feet to the

At one colliery, where the pitch varies between 80 degrees and 90 degrees, a somewhat different system of slant chutes was adopted. The slant chutes were driven across the pitch at about 30 degrees and along the bottom rock. At the junction point of the slant chutes a chute was driven through the coal to the top rock, then turned back again to the bottom rock and slant chutes again driven. There are a number of instances where more than 1,000 feet of such chutes have been driven from the top of one of these rock chutes.

In other cases (depending upon the conditions), instead of driving the rock chute from the Skidmore to the Mammoth, a chute has been driven up the pitch in the Skidmore to the predetermined height, and then a rock chute driven into the coal, the object being to make the opening above the point where the coal ran away and the breast filled with rock. Wherever it has been possible to work this method it has proved successful.

A variation of this method is being tried at the Lansford No. 4 colliery

is being done for the purpose of re-robbing the old workings between the old Water Level gangway and the surface, the lift being about 300 feet. From these slant chutes, straight chutes—5-foot collar and 5-foot leg—are driven up the pitch at about 35-foot centers, depending upon the condition of the gob. The robbing work is started at the top and is continued down the pitch. Great care is taken to keep the robbing faces far enough ahead of the chutes being driven lower down the slope in order to prevent bringing on a squeeze.

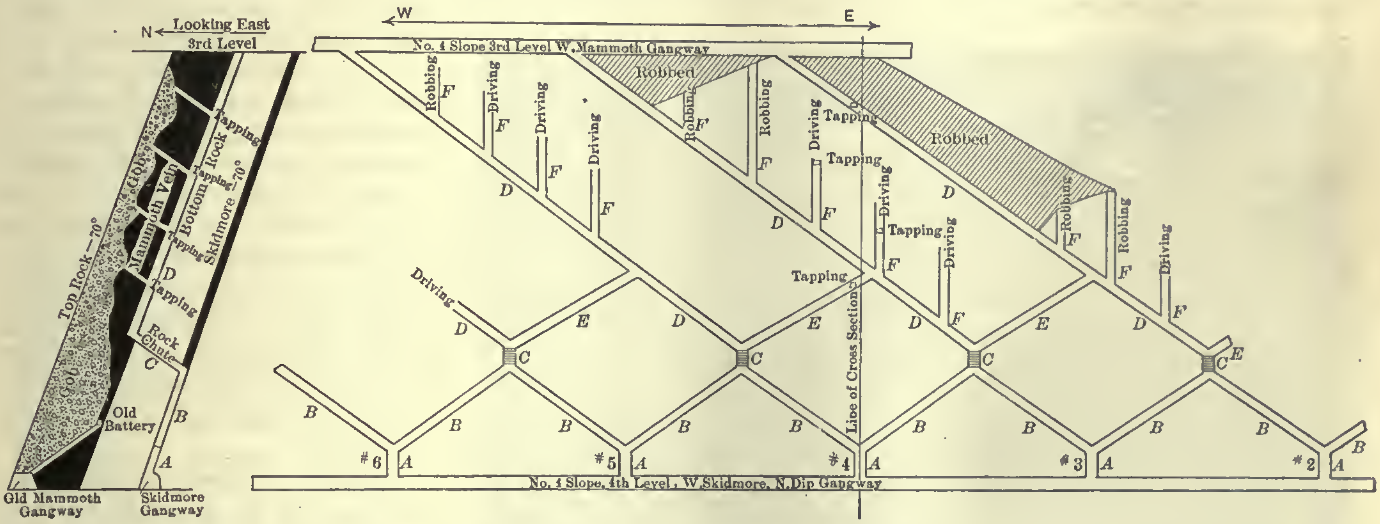
Still another variation is being tried at Lansford No. 4 colliery, on the Slope Level. This plan (Fig. 12) differs from that in the Water Level, in that a 6 ft. × 8 ft. chute is driven from the Skidmore gangway straight up the pitch in the Skidmore bed for 15 feet, these chutes being spaced 140 feet apart on the gangway. From the top of the straight chutes, slant chutes on a pitch of 35 degrees, 6 ft. × 8 ft. in size, are driven along the bottom rock for about 80 feet and connected at the top. From that point

a rock chute—6 ft. × 8 ft.—on a pitch of 35 degrees is driven back to the Mammoth bed, about 30 feet; then long slant chutes are driven on 33 degrees pitch along the bottom rock of the Mammoth to the old level above. The intention was to strike the Mammoth bed above the batteries of the old breasts which were filled with rock.

In many cases the present working is the fourth mining of the same piece of territory. The records show that on the first mining 30 per cent. was recovered; in the first robbing, 16 per cent.; in the second robbing, 8 per cent.; and in the present working, 10 per cent.

At Coal Dale No. 8 colliery workings, the first gangway was driven

If the present method of mining—the Mammoth bed from the Skidmore by means of rock chutes—had been adopted in the original mining, there could have been recovered not only the present 10 per cent., but also the 54 per cent. recovered by means of the three gangways and their airways above mentioned, with their various breasts and chutes.



Cross-Section through Chute No. 4

Fig. 12. Method of Working the Mammoth Bed, as Viewed at Right Angles to the Pitch. No. 4 Slope, Fourth Level, West Skidmore, North Dip Gangway, Lansford Colliery

A.—Straight chutes on bottom rock of Skidmore Bed. Chute 15 feet on 70 degrees, 6 ft. × 8 ft. chute, 140-foot centers. *B.*—Slant chutes on bottom rock of Skidmore Bed. Chute 80 feet on 35 degrees, 6 ft. × 8 ft. chute. *C.*—Rock chutes from Skidmore to Mammoth. Chutes 30 feet on 35 degrees, 6 ft. × 8 ft. chute. *D.*—Slant chutes on bottom rock, Mammoth Bed. Chute 300 feet to third level on 33 degrees, 7 ft. × 7 ft. chute. *E.*—Slant chutes on bottom rock, Mammoth Bed. Chute 80 feet on 35 degrees, 7 ft. × 7 ft. chute. *F.*—Straight chutes on bottom rock of Mammoth Bed. Chutes 60 to 100 feet on 70 degrees, 5 ft. × 5 ft. chute, 35-foot centers.

It has been arranged to make further tests of these schemes when working new territory, in order to made comparisons with the results obtained from the old established pillar-and-breast method.

The chute yardage driven is practically the same in both methods, with a little saving made in the long slant chute method. The great advantage of the long-chute method lies in the coal sliding on the light pitch, with little breakage; the only real drop of the coal being in the straight chute immediately at the robbing point. In the box-chute method there is bound to be considerable breakage in the straight-box chutes unless they are kept full, and this is frequently neglected by the workmen. In any case there is bound to be a certain amount of degradation by the coal grinding in the box chutes.

in the Mammoth bed along the bottom rock, about 60 years ago, and mining was done by the old pillar-and-breast method. After the gangway had been driven to the boundary it was robbed. About 15 years later another gangway was driven through the same territory along the top rock of the bed, and this in turn was robbed. About 30 years ago another gangway was driven midway between these two gangways and the crop; later this gangway was robbed. Five years ago, believing there was a large quantity of coal to be won in this territory from the Mammoth bed, a gangway was driven in the Skidmore bed 30 feet underneath the Mammoth and rock chutes driven on 100-foot centers, to the old Mammoth workings. The present recovery from this section is estimated to be about 10 per cent.

The writer had records kept of the recovery and of the cost of working 900 feet of this territory during the past 5 years, and estimates that the $45,000 or $50,000 which these old openings cost could have been saved. The cross-section, Fig. 13, shows the position of the old gangways and the present Skidmore gangway.

In mining thick coal beds on steep pitches, it will always be possible, even though the most improved methods are used in the original mining, to win some coal by remining, but the cost of obtaining what remains will depend upon the market and wage conditions, and may be prohibitive.

Many years ago no coal except that of the very best fracture and best appearance was mined, because it was the only kind salable. Also, only sizes above chestnut (made

over a ⅞-inch round screen) could be sold. In recent years, all sizes including No. 4 buckwheat (made over a $\frac{1}{16}$-inch round screen) are easily salable, and as a consequence, territory that years ago could not possibly be mined at a profit can now be made to pay.

It has been found of great advantage to make panels of a territory where coal is virgin or where the distance between the Skidmore and the Mammoth beds is too great for practical use of rock holes. The length of these panels depends upon the distance between the beds, the panels in some cases being 600 feet long, and varying up to 1,200 feet. The paneling system has been very much extended during the last 5 or 6 years in the Panther Creek field, and the results have been so satisfactory that the new lifts are being laid out and worked on this plan. At practically all points, none of the beds underlying the Mammoth are workable. The haulageway is being made in the Skidmore, which varies from a thin leader to 3 feet in thickness, and tunnels are being driven at 1,000 feet intervals from the Skidmore to the Mammoth, Primrose, and Orchard beds, and gangways opened in both directions off the tunnels, thus making a section of about 500 feet of each gangway which can be mined and robbed. This will allow an increased number of working faces, and also a greatly reduced time through which the gangways must be maintained. In years to come this will result in a great saving in the mining of the Mammoth bed.

Where a panel tunnel is driven a pillar is left over it, this pillar being recovered when the gangway is being robbed. Every 10 breasts a solid block of coal is left; that is, the coal which would be mined by the eleventh breast is left solid with the exception that the gangway and airway are driven through it. This block is mined on the retreat, but is left on the advance so that in case of a mine fire a solid piece of coal is available from which to begin the fight to extinguish the fire. These pillars also have a checking effect on a "creep."

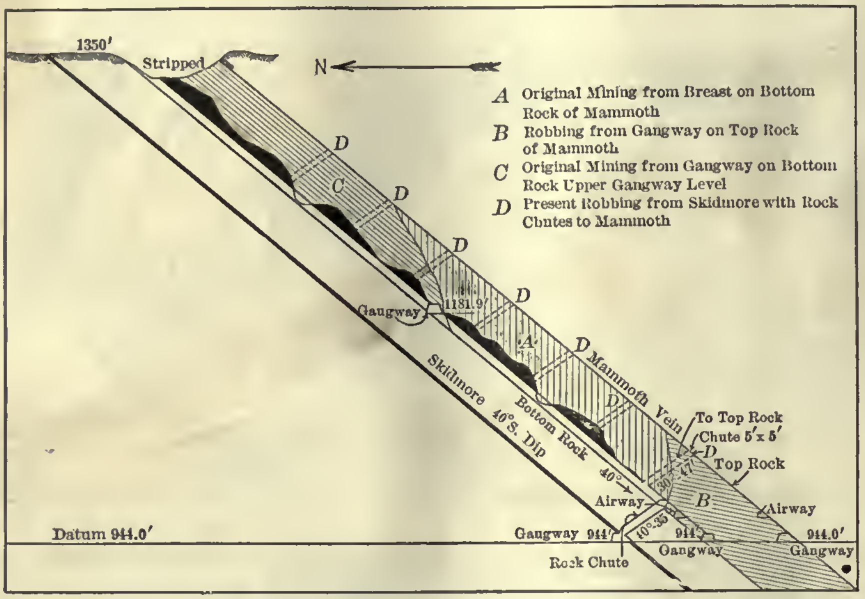


Fig. 13. Cross-Section Showing Original Mining and Present Robbing of Mammoth Bed, Water Level, Coal Dale Colliery

Experience has shown that when the Mammoth gangway, where the coal is from 50 to 60 feet thick or thicker, is being robbed the best results are obtained by bringing back the face 80 to 120 feet per year. To many people this seems unnecessarily slow, and many attempts have been made to hasten the work, but in every case there has been a very decided loss in the amount of coal recovered. This is due to the disturbance of the thick bed causing a general squeeze a considerable distance back from the point of actual robbing and making the maintenance of the gangway not only costly but almost a physical impossibility. In some instances a couple of hundred feet of gangway has been lost, owing to quicker robbing than that mentioned.

When opening a new colliery or a new lift at an old colliery, the question often arises whether it is not better to drive gangways and airways to the boundary lines before opening breasts; also whether it is advisable to open two lifts instead of one. It is believed that with the proper system of paneling better results can be obtained, because it is possible to have several working faces instead of one, enabling quicker development. These panels can be robbed in a reasonable time, thus preventing heavy timber maintenance cost.

With the system of driving the gangways to the boundary there is a period when nothing but development work can be done, and later nothing but robbing work, whereas in the paneling system some sections can be robbing while others are developing, thus keeping the product of more uniform quality.

The driving of gangways and airways in the Skidmore bed has not only reduced the timbering expense, but it has improved the ventilation, for the reason that, the coal is so thin, there are no falls to block the airways.

Ethene, C_2H_4

Ethene, C_2H_4, belongs to the olefin, or ethylene, series. It is known also as olefiant gas, and contains 85.59 per cent. carbon and 14.41 per cent. hydrogen. It burns with a more luminous flame than the paraffins, and is known as an illuminant. It is seldom found in more than a small fraction in natural gas, but is sometimes found in coal mines and is a product of coal gas. It is gaseous under ordinary conditions and boils at −103° C.

Single-Stage Centrifugal Pumps

Characteristics and Principles of Operation—Methods and Apparatus Used in Conducting Tests

By Eugene B. Wilson

The history of the centrifugal pump in the United States dates back to 1818, when some one in Boston constructed what was called the "Massachusetts pump." Centrifugal pumps, until the introduction of the multistage pump about 10 years ago, were considered good pumps for handling large quantities of water to heights not exceeding 20 feet, but their efficiency was low; and so soon as a pump had raised water to a certain height, it made no difference how fast the impeller was rotated the water would not rise higher. With the introduction of the turbine, or multistage centrifugal, pump many features in construction that militated against the efficiency and capacity of the single-stage pump became known, until now fairly efficient pumps are manufactured which will force water to a height of 150 feet and more.

The most important part of a centrifugal pump is the "impeller," which is mounted on a shaft and rotated so as to create a vacuum and permit the atmospheric pressure to force the water to the center or intake of the impeller which in revolving forces the water toward the circumference and out into the pump chamber. The first impellers, roughly speaking, were paddle wheels, which gave rise to excessive friction, due to the contact of the rapidly moving water with the pump casing, and to eddies created inside the pump. With these open runners, it was necessary to fit the blades very close to the pump casing in order to prevent leakage between the blades and the case. As the friction increases as the square of the velocity, the power applied to the impeller was expended in creating velocity and so friction. It was for this reason that, no matter at what speed the impeller was revolved, there was not sufficient pressure generated at the circumference to overcome the pressure due to a fixed head of water in the column pipe, which stood at the maximum height to which the impeller could raise water, say from 10 to 20 feet.

The inclosed impeller was an improvement on the open runner and by its adoption the efficiency of the centrifugal pump was considerably increased. Later the volute pump casing was added, with the object of decreasing the velocity of the water as it left the impellers and converting it into pressure that would overcome the pressure of the water in the column pipe.

Another condition which then had to be overcome was "end thrust" due to taking water in at one side of the pump. There being no balance to counteract this side pressure, it had to be reduced by complicated thrust bearings the best of which were not all that could be desired, but finally this end thrust was overcome by making use of the double suction which gives hydraulic balance by admitting water to both sides of the impeller. While these changes were going on, engineers were applying the theories of hydraulics to practical results and in doing so evolved methods by which they were able to determine in a measure what the duty of a pump would be prior to its construction.

The three principal factors connected with the construction of a centrifugal pump are termed its "characteristics," and as these will differ with the design and diameter of each pump their actual value must be determined by tests. The three characteristics of the centrifugal pump are as follows:

Fig. 1. Goulds Pump-Testing Laboratory

The head developed by the pump; the power required to drive the pump at the head developed; and, the mechanical efficiency developed throughout the range or capacity of the pump. This demands that the impeller must have such dimensions that the required capacity will be obtained at the proper head, when revolving at the speed for which the pump is designed.

In a well-constructed pump the velocity of the water from the inlet to the outlet of the impeller is properly regulated. This is necessary, because, to obtain the highest efficiency under service conditions, the water should enter the impeller without shock, and flow through it with little skin friction. Shock is due to improper design of the passages, and skin friction to rough-

ness of the passages and to the velocity of the moving water. The energy losses occurring on the outside of the impeller are traceable to roughness of surface, to viscosity and to eddies, and these losses increase about as the square of the velocity. To generate a given pressure head the impeller of a centrifugal pump must, within fairly close limits, run at a definite velocity. If a square inch of surface on the outside of the impeller is considered, it is evident that it will meet with a certain resistance as it rotates, and this, multiplied by its velocity, will represent the rate at which it is wasting energy. It follows from this, that of two different sized diameter pumps designed for a given head, the larger one will expose the greater frictional surface and waste a proportionally greater amount of energy, when both rotate at the same number of revolutions per minute. In other words, the external impeller friction in pumps generating a given head increases as the square of the diameter, but while the smaller diameter impeller has the better of the argument it must be rotated at greater speed to accomplish the same work.

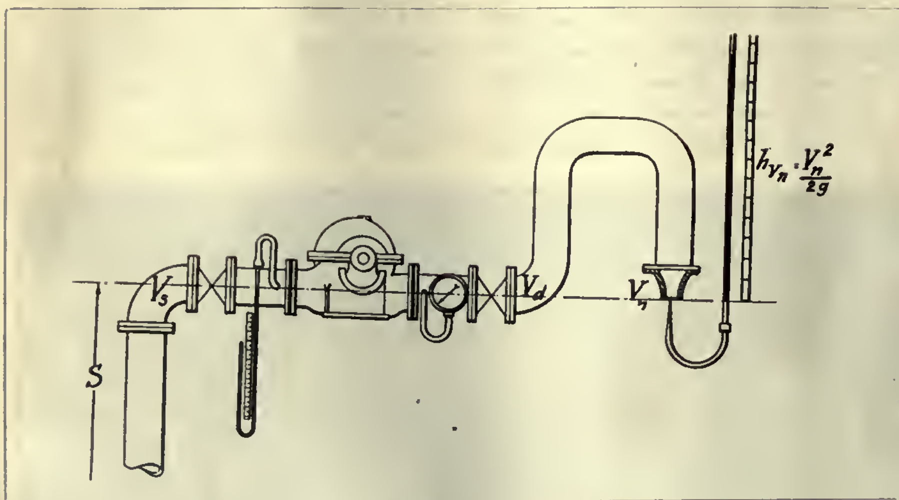


Fig. 2. Nozzle and Pitot Tube Method of Testing a Centrifugal Pump

"Characteristic Curves of Centrifugal Pumps,"* was the subject of a paper by F. W. Greve, Jr., of Purdue University; and to illustrate the performance of such pumps he compared the relative values he obtained from tests. The object of his paper was to describe and illustrate a method of diagramming the experimental data pertaining to centrifugal pumps, and to provide a precise method of comparing the values of those pumps.

Before discussing the curves, the method of performing the tests adopted by one large pump company will be described. The instruments used are calibrated before and after the tests, and calculations for total head include the suction head measured at the entrance of the pump, plus the pressure head measured at the discharge, plus the difference in level of the two gauges, plus the gain in velocity head between the two points where the gauges are connected.

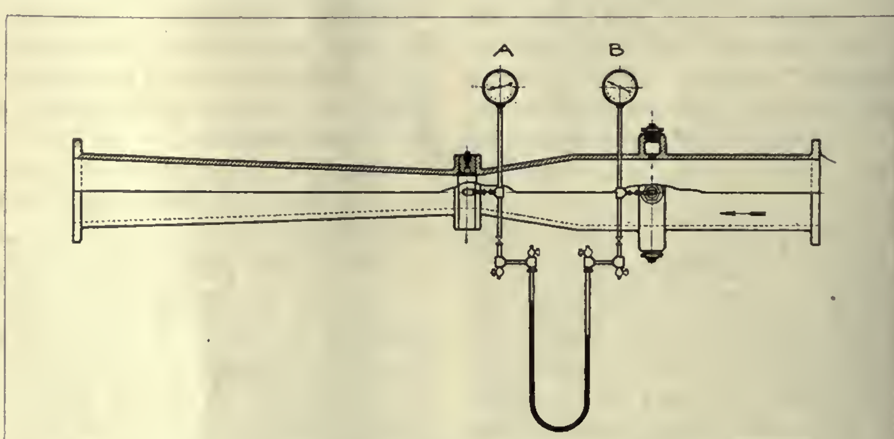


Fig. 3. Venturi Meter, Showing Attachment of Gauges

There are several fairly accurate methods of testing pumps, in all of which the most difficult and most important matter is that of obtaining accurately the capacity, or the gallons pumped per minute. The head pumped against, as well as the suction lift, are always easily obtained by means of pressure gauges, mercury columns, and such standard instruments. The following methods are commonly used for measuring the capacity or rate of discharge of pumps:

1. By displacement in a tank or reservoir of known capacity.

The displacement method is very accurate, if the area of the basin is such that the rise of water during the time of the test is sufficient so that small errors in measuring the elevations do not materially affect the results.

2. By means of a nozzle and Pitot tube.

The nozzle of the Pitot-tube method is reliable when nozzles of correct shape are used, the coefficients of the nozzle are known, and the nozzles are correctly placed. The arrangement of a nozzle and Pitot tube as adopted by the De Laval Steam Turbine Co. is shown in Fig. 2. The nozzle should be placed at the end of a straight run of pipe in order to obtain a uniform jet free from swirls or disturbances. The velocity head may be measured by a water column as shown, or by a mercury column, or by a pressure gauge. Corrections for elevation

* Vol. XLX, No. 8, page 776. Journal of the Western Society of Engineers.

should be made if the gauge is located above or below the center of the nozzle.

If the head indicated by the Pitot gauge is h feet of water, the velocity of the water leaving the nozzle is $v=\sqrt{2gh}$ (g = acceleration of gravity = 32.16), also if the diameter of the nozzle is d inches the theoretical flow through the nozzle in gallons per minute equals $19.63\ d^2\ \sqrt{h}$. In properly formed nozzles the actual flow is 98 to 99 per cent. of the theoretical flow.

Another method of obtaining capacity by means of a nozzle is to arrange the pump to deliver first into a closed tank where the water may become practically stationary. The water is discharged from this tank through a nozzle, the diameter of which is small compared with the area of the tank. The theoretical flow through the nozzle is the same as before or gallons per minute $=19.63\ d^2\ \sqrt{h}$, wherein h is the head in feet of water at the level of the center of the nozzle, and d the diameter of the nozzle in inches. If the pressure in the tank is p pounds per square inch, the theoretical flow is obtained from the formula

$$\text{G. P. M.} = 29.84\ d^2\sqrt{p}$$

3. By means of the double Pitot tube.

The Pitot tube is an instrument consisting essentially of two tubes which are inserted into the pipe, in which the velocity of flow is to be measured. The mouth of one tube is directed perpendicularly to the flow, and a gauge attached to this tube will register the static pressure head in the pipe. The mouth of the other tube is directed against the flow. A gauge attached to this tube will register the static pressure head plus the velocity head. The difference between the two gauge readings gives the velocity head h (feet of water) from which the velocity in the pipe in feet per second is obtained from the formula $V=\sqrt{2gh}$.

If the diameter of the pipe is d inches, the flow through the pipe in gallons per minute equals $19.63\ d^2\sqrt{h}$.

The ordinary and most reliable way of measuring the velocity head is by means of a manometer.

If a mercury manometer is used, and the reading obtained is h_m inches of mercury, the rate of flow through the pipe, in gallons per minute is $20.12\ d^2\sqrt{h_m}$.

If a manometer filled with some other liquid heavier than water of a specific gravity s is used, and if the reading obtained is h_1 feet of liquid, the flow through the pipe, in gallons per minute, is

$$19.63\ d^2\sqrt{(s-1)h_1}$$

This method gives fairly accurate results, if readings are taken at many different points in the pipe and the average value of the readings obtained is used in computing the capacity.

4. By means of the Venturi type of meter.

The Venturi method, shown in Fig. 3, is used quite extensively, especially in connection with recording instruments, in water works installations and in connection with boiler feed-pumps and general service pumps.

The Venturi meter, which may be placed anywhere in the discharge line of the pump, preferably as far away from elbows or other fittings as possible, consists of a piece of pipe converging in the direction of the flow to a small diameter known as the throat, and from there on diverging until the full diameter of the pipe is again reached. The diameter of the throat is generally half the diameter of the pipe, but sometimes less.

The principle of the Venturi meter is based upon Bernouilli's law that the sums of the pressure head and velocity head at two sections are equal; or in other words, the difference in pressure between the two gauges B and A equals the difference in velocity heads at the corresponding sections. Knowing the areas, the rate of flow can easily be calculated from the readings on gauges B and A, or on the manometer if such is used.

Let

D = diameter of pipe in inches;

d = diameter of throat in inches;

H = Venturi head (difference in readings on gauges B and A) in feet of water;

h = Venturi head in inches of mercury (when using a manometer).

The theoretical flow is expressed in gallons per minute as follows:

$$\text{G. P. M.} = \frac{19.63\times D^2\times\sqrt{H}}{\sqrt{\left(\frac{D}{d}\right)^4-1}}$$

$$\text{G. P. M.} = \frac{20.12\times D^2\times\sqrt{h}}{\sqrt{\left(\frac{D}{d}\right)^4-1}}$$

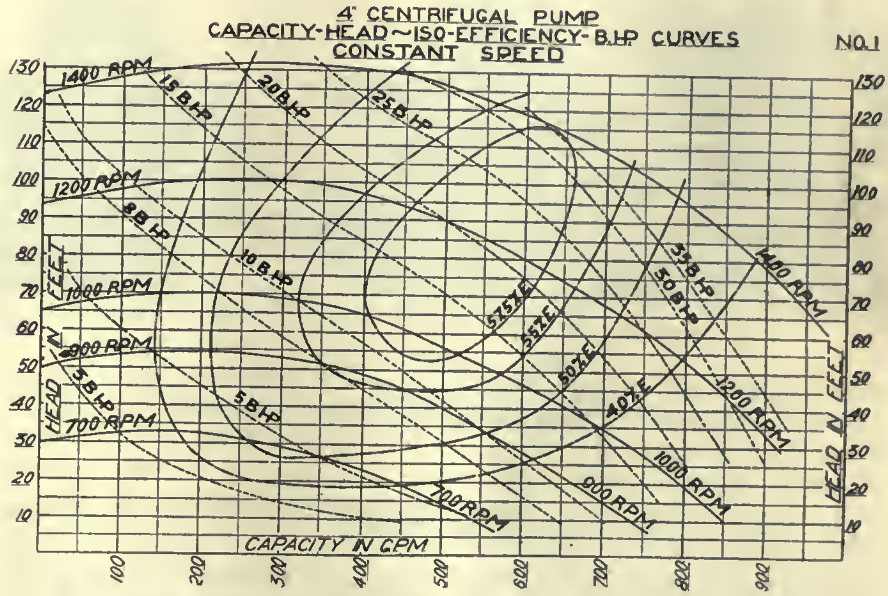


Fig. 4

With a coefficient of the meter of .99 the actual flow through the meter will be

$$\text{G. P. M.} = \frac{19.434 \times D^2 \times \sqrt{H}}{\sqrt{\left(\frac{D}{d}\right)^4 - 1}}$$

$$\text{G. P. M.} = \frac{19.92 \times D^2 \times \sqrt{h}}{\sqrt{\left(\frac{D}{d}\right)^4 - 1}}$$

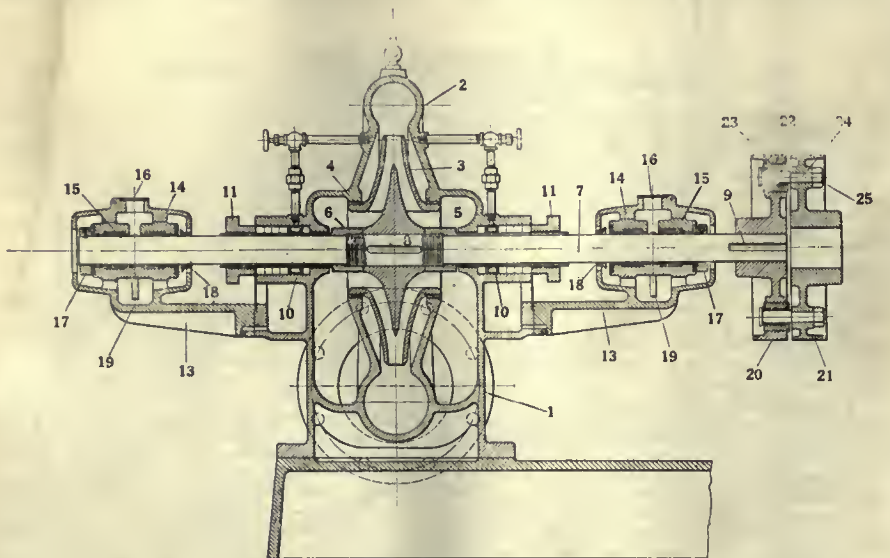


Fig. 5. Section of a Double-Suction Cameron Single-Stage Centrifugal Pump Arranged to be Belt Driven

If the flow is estimated in gallons per 24 hours, the formulas will be as follows: Theoretical flow

$$\text{Gal. per 24 hours} = \frac{28{,}267 \times D^2 \times \sqrt{H}}{\sqrt{\left(\frac{D}{d}\right)^4 - 1}}$$

$$\text{Gal. per 24 hours} = \frac{28{,}973 \times D^2 \times \sqrt{h}}{\sqrt{\left(\frac{D}{d}\right)^4 - 1}}$$

Using a coefficient of .99

$$\text{Gal. per 24 hours} = \frac{27{,}984 \times D^2 \times \sqrt{H}}{\sqrt{\left(\frac{D}{d}\right)^4 - 1}}$$

$$\text{Gal. per 24 hours} = \frac{28{,}683 \times D^2 \times \sqrt{h}}{\sqrt{\left(\frac{D}{d}\right)^4 - 1}}$$

During the different tests given centrifugal pumps the speed is kept constant, but the delivery is controlled by a throttle valve in the discharge pipe. When the pump is discharging water at a constant rate, the corresponding total head generated is read from the gauges. In Fig. 1 the testing laboratory is over a 60,000-gallon concrete tank provided with baffle plates so arranged that a pump discharging 10,000 gallons of water per minute may be tested. During tests a series of readings are taken, commencing with the gate valve wide open and continuing at fixed points until the valve is closed. For each setting of the valve the head is measured by the gauges, and the capacity is measured by calibrated nozzles to determine the rate of discharge under a known head. For all tests the prime movers are electric motors of known efficiency, and the horsepower delivered to the pump is readily determined by suitable electrical instruments. From the voltmeter and the ammeter, readings are taken simultaneously, and from the known efficiency of the motor the horsepower consumed in driving the pumps at the same instant is calculated. The rate at which mechanical work is done on the water is obtained by multiplying the head generated by the rate of delivery, and on dividing this product expressed in appropriate units by the power delivered to the pump shaft, the mechanical efficiency is found. The data from these tests and calculations are plotted and the complete characteristic of the pump obtained. The design of each pump is thus based upon correct hydraulic theory, and the makers are able to predict accurately the performance of a new pump, from tests made on pumps previously built.

On diagram Fig. 4, which is from Mr. F. W. Greve, Jr.'s paper, there are three series of curves which have been plotted from the results of tests. The full line shows the relation between head in feet and capacity in gallons per minute the speed remaining constant for each curve. These curves show that the head decreases with increase of capacity, also that the maximum head does not take place at the minimum discharge, but at a point equal to about one-third of the maximum. As the curves seem to have a common center or are concentrically parallel, the relation between head and capacity can be established by sketching in a new curve for the desired speed, the curves established from the test data acting as guides.

The diagonal dotted line across the diagram represents the horsepower supplied to a pump to give a definite discharge at a constant speed. From this it is seen that the horsepower increases with the discharge for a given speed until the point of maximum capacity has been reached; and it shows also the horsepower required to discharge any quantity of water against any head and at any speed within the limits of the pump.

The iso-efficiency curves, are represented by the dotted lines forming ovals. These show the relations of head, speed, capacity, and horsepower required to give a definite efficiency. The major and minor axes of each curve intersect in a common point of origin, about which the curves are concentric. This point of intersection is also the point of maximum efficiency. The fact that these efficiency curves and brake horsepower curves are concentric is important, as any questions relating to speed, discharge, head, horsepower input and output, are quickly answered from the diagram. While centrifugal pumps are now scientific commercial propositions which possess so many advantages over reciprocating pumps that old line pump concerns manufacture them, the fact remains that in coal mines the impellers, and in some

cases the casings, must be constructed of acid-resisting alloys, instead of iron or steel. The stuffing boxes on the shaft must be sealed also in some way so that air will not enter the pump. The Cameron and the Goulds companies use a water seat; that is, water is supplied to the boxes at the pressure head against which the pump works. Besides being adapted to almost any kind of pumping, centrifugal pumps are driven by almost any kind of power. For outside mine work, boiler feeding, cooling towers, condensers, etc., the favorite power for centrifugal pumps is the direct-connected turbine wherever it is possible to supply it with steam; however, the electric driven pump is the more suitable and convenient below ground and at some distance away from the power plant on the surface.

Whenever arrangements are such that neither electric power nor steam turbine power can be used to advantage, the pump may be connected to a steam engine and be geared or belt driven to attain a high speed.

The size of the impeller and other data relative to the actual construction of these pumps are not made public by the makers, therefore the accompanying Table 1 is general, but the information it contains can be applied to all pumps because the efficiency factor is low for the normal capacity; and knowing the minimum revolutions per minute, any reliable centrifugal pump manufacturer can duplicate the performances.

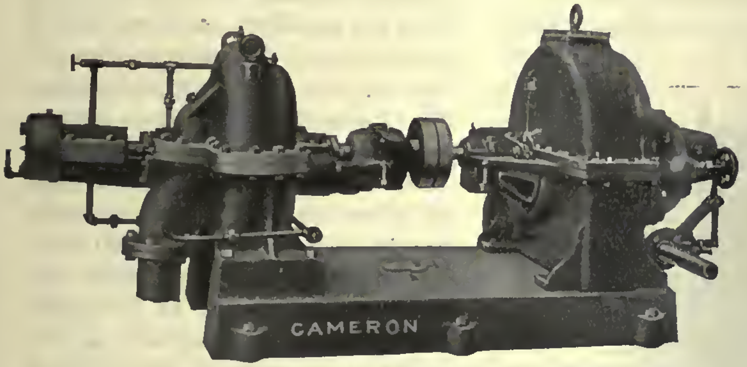


FIG. 6. CAMERON TURBINE-DRIVEN PUMP

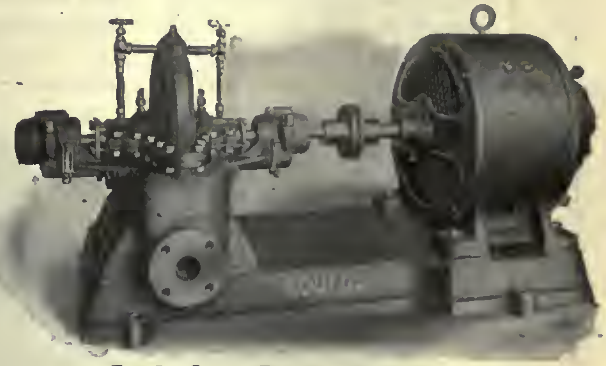


FIG. 7. GOULDS ELECTRIC-DRIVEN PUMP

It will be seen from the table that there are two sizes of pumps available for obtaining the same head. The high-speed pattern "S" and the low-speed pattern "L." Where the speed of the pump is not determined by the prime mover, the high-speed pump is desirable because it is possible to use a smaller diameter impeller for any head; thus the frictional losses are reduced and the highest efficiency obtained. In addition to this, each pattern has two speeds, a maximum and a minimum, and in the table the minimum is given. To obtain the maximum speed for a pump 2 S, double the minimum speed given in the table.

The maximum speeds for the low-speed pumps of the "L" class are the minimum speeds of the "S" class pumps, for example the minimum speed of a 2 S pump is 1,130, which is the maximum speed of the 2 L pump. The maximum speed of the 4 L pump is 860, which is the minimum speed of the 4 S pump, etc. By using this table, when three factors are known the fourth can be found, thus making a short cut to the information desired.

To find the horsepower required to drive a single-stage, double-suction centrifugal pump for any capacity against any head up to 150 feet: Multiply the capacity desired in gallons per minute by the total head in feet; divide by the constant 3,960, and then divide the result obtained by the efficiency of the pump.

The efficiency of centrifugal pumps varies according to the size of the impeller, the speed with which it is rotated, the head against which the water is delivered, and the quantity of water delivered.

The rule may be expressed in brake horsepower (B. H. P.) as follows:

$$\text{B. H. P.} = \frac{Q \times H}{3{,}960 \times E}$$

In this equation Q represents the capacity desired in gallons per minute, H is the desired total head in feet, and E is the efficiency of the pump expressed as a decimal.

TABLE 1. SINGLE-STAGE, DOUBLE-SUCTION CENTRIFUGAL PUMPS

Size	Size of Suction and Discharge Pipes*	Capacity Gallons Per Minute		Minimum Revolutions Per Minute For Total Heads in Feet						Efficiency of the Pumps
		Normal	Maximum	20 Feet	40 Feet	60 Feet	80 Feet	100 Feet	120 Feet	
2 S	2	100	125	1,130	1,600	1,960	2,260	2,530	2,780	.47
2 L	2	100	125	695	985	1,210	1,390	1,560	1,710	.45
3 S	3	200	275	1,005	1,425	1,745	2,010	2,250	2,470	.55
3 L	3	200	275	605	855	1,045	1,210	1,350	1,480	.52
4 S	4	400	500	860	1,220	1,495	1,725	1,930	2,110	.60
4 L	4	400	500	535	755	925	1,065	1,190	1,305	.57
5 S	5	600	750	755	1,070	1,310	1,510	1,690	1,850	.65
5 L	5	600	750	490	690	850	980	1,095	1,200	.60
6 S	6	800	1,100	670	950	1,165	1,340	1,500	1,640	.68
6 L	6	800	1,100	435	615	755	870	975	1,070	.63
8 S	8	1,500	2,200	505	710	875	1,005	1,125	1,235	.70
8 L	8	1,500	2,200	380	535	655	755	845	925	.66
10 S	10	2,500	3,300	455	640	785	905	1,010	1,110	.72
10 L	10	2,500	3,300	335	475	580	670	750	820	.68
12 S	12	3,500	4,500	380	535	655	755	845	925	.72
12 L	12	3,500	4,500	285	400	490	565	635	695	.70
15 S	15	5,000	7,200	325	460	560	645	725	795	.72
15 L	15	5,000	7,200	240	340	415	475	535	585	.70

* Some makers use a larger suction than discharge pipe.

Example.—What is the brake horsepower required to drive a 6 S pump, having an efficiency of .68, against a head of 100 feet and at the same time deliver 800 gallons water per minute? Substituting in formula.

$$B. H. P. = \frac{800 \times 100}{3,960 \times .68} = 29.7$$

Under the same conditions except as to quantity, what horsepower will be required to raise 1,100 gallons per minute? Ans. 40.8 B. H. P.

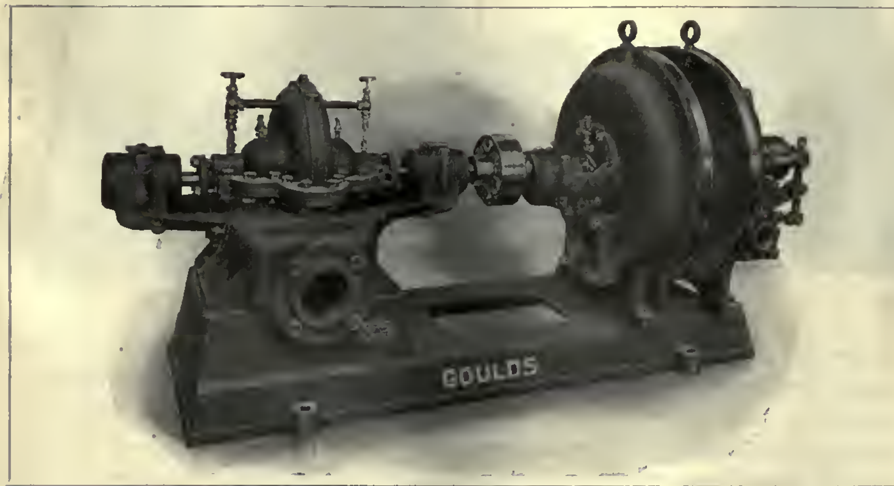


Fig. 8. Goulds Turbine-Driven Pump

The writer is indebted to the Cameron, Goulds, and De Laval companies for assistance in the compilation of this article as well as to Professor Greve, and the Western Engineers' Society of Chicago.

Bulletin No. 8, Illinois

The explosion at the North mine, Royalton, Ill., on October 27, 1914, in which 52 lives were lost, adds force to the recommendation leading to safer mining made in Bulletin 8, Coal Mining Practice in District VI, by S. O. Andros. This bulletin, published by the Illinois Coal Mining Investigations Cooperative Agreement, describes methods of mining in Bed 6 east of the Duquoin anticline in Franklin, Jackson, Perry, and Williamson counties. This district with an annual production of over 12 million tons is one of the most important in Illinois, and its undeveloped coal resources are so great that it will doubtless become the most important. The output of the district is 20.8 per cent. of the total production of Illinois. The face workers average 7.6 tons of coal daily as compared with an average of 5.9 tons per face worker in the mines of all other districts in the state. Bed 6 in this district varies in thickness from 7½ to 14 feet and averages over 9 feet.

The subject of ventilation is a vital one to the district inasmuch as there have been serious explosions of gas and dust in many mines resulting in much loss of life and destruction of property. The disastrous explosion at the Zeigler mine, in 1905, and the fire in 1908, will be recalled by those familiar with Illinois mining history. Frequent explosions of less magnitude in other mines, many of them resulting in loss of life and all of them entailing great expense in recovering the mine or a portion of it, have caused this district to be regarded properly as a dangerous one.

Copies of this bulletin may be obtained from the Illinois Coal Mining Investigations, Urbana, Ill.

Anthracite Region Prosperous

At no time has the anthracite region of Pennsylvania enjoyed such a period of peace and prosperity as that of the last 10 years. Edward W. Parker says in his "Production of Coal in 1913," published by the United States Geological Survey, that it requires no straining stretch of credulity to believe the foregoing claim when the financial concessions made by the operators are taken into consideration.

The first of these was the establishment in 1901 of the summer discounts which have resulted in a marked increase in the number of days the employes have been able to work, and in the uniform distribution of the shipments throughout the 12 months of the year. From a minimum of 195 working days in 1906 the average has ranged as high as 257 in 1913, with a mean average for the last 10 years of 220 days. In 1913 the railroad shipments reported to the Bureau of Anthracite Coal Statistics amounted to 69,069,628 long tons, of which 50 per cent. were sent out during the winter months and 49.7 per cent. in the summer months, thus distributing employment evenly throughout the year.

Wage rates since 1902 have been advanced 21 per cent. (10 per cent. in 1902 and 10 per cent. more in 1912), and as the average working time in that decade exceeds that of the previous one by 23 per cent., it may be computed that the average yearly earnings in 1913 were nearly 45 per cent. more than before the spring reductions went into effect and before the strike of 1902 resulted in the first 10 per cent. advance in wages. Thus the mine workers are now getting both more work and more pay.

The publication above quoted contains a table showing, together with the total coal production in the United States, the production of anthracite in short tons since the first shipment of 55 tons in 1807. It is here appended, by decades, to show what the enterprise of the operators has been able to accomplish in the last hundred years:

1820	12,000
1830	215,272
1840	967,108
1850	4,138,164
1860	8,115,842
1870	15,664,275
1880	28,649,812
1890	46,468,641
1900	57,367,915
1910	84,485,236
1913	91,524,922

Harlan Coal Field

In Southeastern Kentucky—Geology of the Region and Description of the Coal and the Extent to Which it is Developed

*By R. J. Sampson**

Harlan County is in the southeastern part of Kentucky on the boundary line between Kentucky and Virginia. It is separated from Virginia and her railroads by the Cumberland Mountains, along the crest of which is the state line. On the eastern side, the Pine Mountain cuts off the main part of the county from the Kentucky River and the railroad which follows that stream. Therefore all of the freight to and from the county must follow the route picked out centuries ago by the waters of the Cumberland River.

The principal part of the county is drained by the Clover Fork, Poor Fork, and Martin's Fork which form the headwaters of the Cumberland River. From the town of Harlan these streams flow together as the Cumberland River.

The country is mountainous, the valleys are narrow and there is only a small area of tillable bottom land near the beds of the streams.

The mountains vary in height from the low spurs to the main ridges, which in instances rise to more than 2,000 feet above the valleys.

General Geology.—This field is a part of the "Cumberland Gap coal field." The geological structure is that of a flat-bottomed syncline with its axis almost parallel to the Cumberland River.

From this axis the rocks gradually rise until they are sharply upturned in the Pine Mountain on the northwest by the Pine Mountain Fault, and in the Cumberland Mountains on the southeast by the Powell's Valley Anticline. Between these two boundaries lie the Black Mountains and Martin's Fork Ridge.

The outcropping rocks in the last-named mountains are sandstones, shales, and coal beds. No continuous limestone beds have been found. However, a bed of fossil limestone about 12 inches thick is reported as having been seen high in the Big Black Mountain.

The shales and sandstones are about equally developed, the sandstone probably predominating. The lower part is principally sandstone and contains some fairly coarse conglomerate.

The Lee conglomerate, called here the "Lee sandstone," is the lowest division of the coal measures and does not outcrop in the Harlan field, but it is seen on the north flank of the Pine Mountain where it is brought up by the fault. Above the Lee occurs some 2,300 feet of sandstone and shale in about equal proportions.

In the Big and Little Black mountains and the Martin's Fork Ridges and their spurs, occur the workable coal beds. The coal in the Pine Mountain and the Cumberland Mountains is badly crushed and so steeply inclined as to be practically worthless at this time.

The Coals.—From the foot to the crest of the Black Mountains a number of coal beds outcrop, but here only those are described which in some part of the district have economic value. They are described in order beginning at the bottom.

The Harlan seam is the lowest workable one in the mountain and is the most regular and most valuable. It lies between massive sandstone beds, the top one usually less than 3 feet above the coal and frequently resting on it, with probably an average of 9 inches of shale between. Underneath the coal there is usually a shale bed of varying thickness, which is too hard to be cut by coal mining machines.

The horizon of this coal on the mountain is readily located by the fact that it lies 250 feet over the Cawood sandstone which outcrops all along the river bed, in many instances forming prominent cliffs.

The coal in this seam has a bright luster, is comparatively heavy, but has so many cross bedding planes that it would not block well were it not for a thin strip of "mother" coal which seems to cement it. In almost every block of any size this strip with a dull luster may be found.

The bed, which is generally known as a 4-foot seam, has been opened in numerous places in the central, southern, and western portions of the county. Eastwardly from the town of Harlan and at a distance of about 14 miles, it goes under drainage. Here it shows a section of 3 feet 6 inches of clean coal.

On the Clover Fork, 1 mile above the town of Harlan, the Harlan Town Coal Co. has opened this seam. They found from 52 to 56 inches of clean coal in a top bench, underlain by a shale parting of from 3 to 6 inches with a 14-inch bench of coal underneath. In one place in this mine the coal from top to bottom measures 6 feet and 6 inches with a 4-inch parting, 14 inches from the bottom.

The Clover Fork Coal Co., operating 1 mile above the Harlan Town Co., has from 50 to 54 inches of clean coal. Between these two mines the bottom bench seems to have disappeared, or the interval has increased and the bottom bench has not been found. The Lynn Hollow Coal Co. (now the Rex Coal Co.) operating just across the river from the Clover Fork Co., and in the Big Black Mountain, found 48 inches of clean coal.

The Golden Ash Coal Co., opening in the Big Black Mountain, 2½ miles from the town of Harlan has the same section as the Lynn Hollow. The Wallin's Creek Coal Co., operating the next lease up the river from the Golden Ash, found a section of 48 to 52 inches clean. The Harlan Coal Mining Co. opening on Clover Fork in the Little Black Mountain, at a distance of 3½ miles

*405 S. Campbell St., El Paso, Texas.

from the town of Harlan, found 45, 46, and 47 inches of clean coal, in a spur. This should increase in the main ridge to 54 or 56 inches, as shown in an opening in a hollow just west of their operations.

The Ages Ridge Coal Co., operating on Clover Fork in the Big Black Mountain, 5 miles from the town of Harlan, found from 42 to 46 inches of clean coal. This is expected to increase to a maximum of 59 inches, which is the thickness of a section exposed in an old opening near the center of their property. The Catron Creek Coal Co., operating in the Little Black Mountain, on Martin's Fork, found in their several openings, 49 to 54 inches of clean coal. The Pineville Coal Mining Co., operating on Martin's Fork in the Little Black Mountain, just opposite the Harlan Town Co., found practically the same section as that company.

In general, the coal in the Big Black Mountain shows a section from 48 to 50 inches. In the Little Black Mountain it is as a rule thicker, from 52 to 56 inches, and with a bottom bench of from 14 to 24 inches, parted by a shale bed of from 3 to 18 inches in thickness. In Martin's Fork Ridge it has not been thoroughly prospected, but where exposed it shows very much the same section as in the Big Black Mountain, but usually has the same parting as in the Little Black Mountain. In the eastern part of the country the coal is below water level.

On Ewings Creek in the lower or western end of the country, on the property of the Wilhoit Coal Co., there occurs a seam of coal that is from 140 to 160 feet below the Harlan coal. It is 36 inches thick, usually with partings. This is the only place in the county where it has been found with this thickness, but it has not been thoroughly prospected.

The Harlan seam, in general, dips slightly to the northeast, and samples taken from the outcrop, 1,600 feet above sea level, analyze as follows: Moisture, 1.755; volatile matter, 38.265; fixed carbon, 55.849; sulphur, .898; ash, 3.491.

Bed, or seam, *B*, which has no importance in the western part of the county, is the most persistent, though not the most valuable, in the eastern portion. It lies about 140 feet over the Harlan coal. In the extreme eastern end of the county it attains a thickness of 3 feet 6 inches, clean. No analysis of this coal is at present available.

The Kellioka seam, which occurs about 200 to 250 feet over the Harlan, has not been thoroughly prospected in the lower or western portion of the county; however, where opened it shows a mining section of 3 feet 6 inches to 4 feet.

It is mined at Keokee, Va., as the McConnell seam, and is probably the Darby or No. 5 seam mined at Darby, in the pocket district of Virginia, as well as the Taggart, mined at Roda, Va.

The Wisconsin Steel Co., mining this coal at Benham, Ky., 27 miles east of Harlan, has 5 feet 6 inches of coal practically without parting.

There is also a seam in the eastern end of the county, about 60 feet over the Kellioka, which averages about 3 feet 6 inches clean. The Wisconsin Steel Co. also mines this coal to mix with the Kellioka to make coke.

The Kellioka coal at an elevation of 1,850 feet above sea, analyzes as follows: Moisture, 1.779; volatile matter, 38.514; fixed carbon, 54.920; sulphur, .957; ash, 3.844.

Wallin's Creek coal seam, named for the Wallin's Creek, of the Cumberland River, has in that locality a thickness of 9 feet, with a 6-inch parting 18 inches from the bottom, leaving a top bench of 7 feet, clean.

The Terry's Fork Coal Co., operating on Terry's Fork of Wallin's Creek, found the section given above.

Analysis of Wallin's coal at elevation of 2,500 feet above sea: Moisture, 2.355; volatile matter, 37.356; fixed carbon, 52.115; sulphur, .879; ash, 7.594.

The Looney seam opened in several places in the high knobs of the Little Black Mountain, shows from 4 feet 5 inches to 5 feet of coal, usually parted by a little shale.

The Lower High Splint coal lying from 300 to 350 feet over the Looney, in the Big Black Mountain shows more than 3 feet of minable coal.

The Middle High Splint averages about 3 feet in the Big Black Mountain.

The Upper High Splint occurs about 400 feet over the Looney and is the most valuable of the high seams in the Big Black Mountain. It varies from 4 to 6 feet of coal, practically without parting. In one place it shows 9 feet 5 inches of coal with a 6-inch shale parting 1 foot from the floor.

A 6-foot seam, about 80 feet under drainage has been reported. This report is not very reliable as there are not many data to either confirm or disprove it.

History of Development.—For several years past companies and individuals have been acquiring land in Harlan County. However, no move was made toward building a railroad until the early spring of 1907, when Mr. T. J. Asher began the construction of a 13-mile road up the Cumberland River from Wasioto, to reach a couple of operations which he was installing on his own property.

This was known as the Wasioto and Black Mountain Railroad. The Louisville & Nashville Railroad took it over and completed it to Benham, a distance of 27 miles above Harlan.

On the completion of this road a branch line was started. This spur followed the Clover Fork of the Cumberland River for a distance of 5 miles and was there stopped. That road was put into operation on August 3, 1912. In the summer of 1913 a spur some 3 miles in length was built up Martin's Fork, and put into operation in the winter of that year.

As soon as it was known that the railroad would be completed to Harlan, several mining companies were organized. The first of these to

begin shipping coal was the Terry's Fork Coal Co., now known as the Wallin's Creek Coal Co. They opened the Wallin coal on Terry's Fork of Wallin's Creek. A spur about 1 mile long was built to their tipple from Wallin's station.

The company installed an electric plant, built a tipple and an incline 6,000 feet long. The upper part of the incline is operated by gravity, the lower is an engine plane. Their first shipment was made in the summer of 1911. The output is from 600 to 700 tons per day. The 1913 output was 89,147 tons.

The Wilhoit Coal Co. next began shipping in the early winter of the same year. Their operation was put in on Ewings Creek, coal being taken from the Harlan seam.

An electric plant has been installed, consisting of one Morgan-Gardner 150-kilowatt generator, belt driven, two Sullivan and one Morgan-Gardner short-wall chain cutters. Mules are still used for haulage, but eventually will be replaced by electric locomotives. The output is from 300 to 400 tons per day. The 1913 output was 37,568 tons.

The Harlan Town Coal Co. made their first shipment July 7, 1912. The mine is in the Little Black Mountain, in Clover Fork, 1 mile above Harlan.

Their equipment consist of one Morgan-Gardner 250-kilowatt generator, belt driven, two 8-ton Morgan-Gardner combination gathering and hauling motors, one Morgan-Gardner and one Sullivan short-wall chain cutter. They mine the Harlan seam and have an output of from 600 to 800 tons per day. Their 1913 output was 117,369 tons.

The Clover Fork Coal Co. began shipment at the same time as the Harlan Town Co. Their mine is also in the Little Black Mountain, on Clover Fork, 2 miles from the town of Harlan. No mechanical equipment was put in except an engine to operate the shaking screens. The mine is in the Harlan seam and has a capacity of 1,000 tons daily. The 1913 output was 139,700 tons.

The Lynn Hollow Co. began shipping in the winter of 1912. The mine is in the Harlan coal in the Big Black Mountain. The company has installed no mechanical equipment. Their capacity is 500 tons per day. Their output for 1913 was 4,610 tons.

The Golden Ash Coal Co. made their first shipment in the early fall of 1913. Their output is from 300 to 500 tons daily. The mine is in the Harlan seam in the Big Black Mountain, 3 miles from the town of Harlan.

The Wallin's Creek Coal Co. began shipping about the same time as the Golden Ash Co. Their mine is in the Harlan coal in the Big Black Mountain 3½ miles east of Harlan. Their first shipment from this mine was made in the winter of 1912. The total output for the year 1913 was 89,147 tons.

The original company, the Harlan Town Coal Co., installed electrical equipment throughout. One feature of their plant is of peculiar interest, in that they have departed from the customary gravity incline and installed a retarding conveyer, of the rope-disk type. From center to center the length is 825 feet, the last 300 feet, crossing the river, being a suspension bridge, carrying the conveyer, on a curve of 600-foot radius. At the foot the retarder discharges to a belt conveyer 235 feet long which carries the coal to the screens. The lump from these screens is loaded by a boom loader. The capacity of the conveyer is 200 tons per hour. The output in 1913 was 117,360 tons.

The Ages Ridge Coal Co. went into operation in the spring of 1913. The capacity is 1,000 tons daily. The present output being from 250 to 400 tons per day. In 1913, 11,584 tons were shipped.

The Catron Creek Coal Co. began shipment in the fall of 1913. They operate two mines, the coal from both going over one tipple. The eventual output of these two mines combined should be about 2,000 tons daily. The 1913 output was 5,730 tons.

The Pineville Coal Mining Co. began shipment about the same time as the Catron Creek Co. Their operation is in the Harlan coal, in the Little Black Mountain, just opposite the Harlan Town Coal Co. at a distance of 2 miles from Harlan.

They have no mechanical equipment. The output is from 200 to 400 tons daily.

The Wisconsin Steel Co., operating in the Kellioka coal and a seam some 60 feet above the Kellioka, began shipment in 1911. The mines are located at Benham, Ky., 27 miles from Harlan. In 1913 the output was 214,540 tons.

At present all of their coal is converted into coke, for which purpose they have built 300 ovens of the beehive type, a breaker equipped with two crushers and flight conveyers motor driven. The slack is conveyed to the ovens by electrically driven larries. The output is twenty cars of coke per day.

Power is supplied by two 338-kilowatt and one 150-kilowatt generators direct connected.

A camp of two hundred modern mine houses of various designs, and painted in different colors, a club house and a handsome residence for the superintendent, have been built. A modern building used by the Y. M. C. A. was opened in 1912, and also a modern hotel.

The company has sought in every way to make their men comfortable and contented.

As the Stonega Coal and Coke Co.'s operation at Keokee is really a Virginia mine, it is not described here, although 68,237 tons of coal were mined in Kentucky.

An extension of the road up Martin's Fork and a spur up Catron Creek of this fork, would tap the best of the Harlan coal and would mean the installation of more coal operations.

It is also a logical conclusion that some day the road that follows Colver Fork will be completed to a point opposite Keokee, if they do not tunnel the Black Mountain and form a junction with the Virginia and Southwestern or build into Ap-

palachia to connect with the Cumberland Valley Division of the Louisville & Nashville.

All of the coke made in the county at present goes to the Wisconsin Steel Co. furnaces in South Chicago. The coal from the other operations finds a ready market in the west, north, and south, which it can reach over the Louisville & Nashville Railroad and its connections. The coal and coke from Keokee goes east and south over the Southern Railway.

"The Hygrograph"

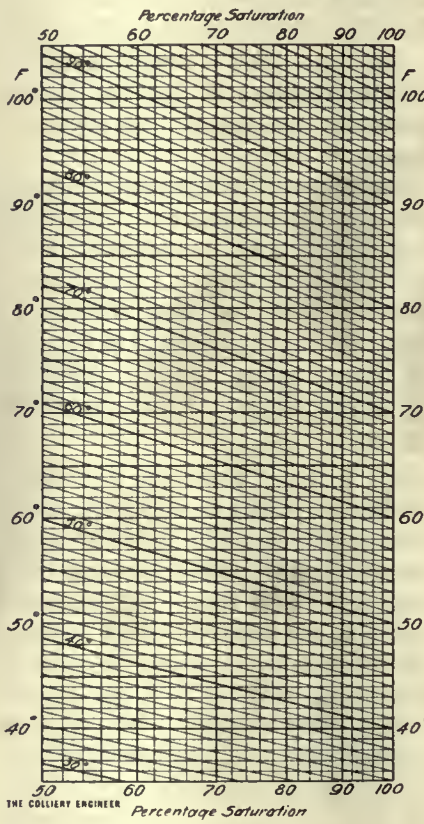
*By Henry Briggs**

The placing of hygrometers in main intakes and main returns having been enforced by Section 71 of the Coal Mines Act of Great Britain, the manner of determining the relative humidity of the air from the readings of the wet-and-dry bulb thermometers has become of some practical importance.

Believing that something of the nature of a simple chart, to take the place of the tables in common use for reducing hygrometer readings, would be useful, the writer has been able to evolve the form shown in Fig. 1, for which he suggests the name "hygrograph." The chart was constructed from Glaisher's Hygrometrical Tables, which were drawn up to suit air-currents of moderate speed, and for that reason were selected rather than the more recent tables issued by the United States Department of Agriculture, since the latter apply to comparatively rapid air velocities.

The readings of the two thermometers having first been taken, the chart is used as follows: The positions corresponding to the two readings are noted on the scale running up the right-hand side of the chart. The inclined line indicating the wet-bulb reading is then followed until it meets the horizontal line indicating the dry-bulb reading. Then, by aid of the vertical lines, the point of intersection is referred to the scale labeled "Percentage Saturation" on the bottom or top of the chart. In this way the relative humidity is shown by inspection.

In the design shown, the range of temperature (dry bulb) is from 35° to 105° F., and the range of relative humidity from 100 to 50 per cent.



The Hygrograph

It is believed that the conditions as to temperature and humidity generally met with in British mines are covered by the chart.

The temperature scales are graduated to single degrees Fahrenheit, and the humidity scales in even percentages. It is not difficult to estimate single percentages by the eye.

A second form of hygrograph has been designed for countries hotter and drier than our own; it includes higher temperatures and degrees of humidity down to 20 per cent.

The writer has tested the chart against Glaisher's tables for a large number of points, and finds the maximum discrepancy between the two to be 1 per cent. The usual difference, however, is much less than that, the average discrepancy for 50 readings scattered over the chart being only ¼ per cent. The accuracy is therefore amply sufficient for practical purposes.

The hygrograph is by no means the first attempt to obviate the necessity of using hygrometrical tables. About the year 1887, Mr. H. C. Russell published a diagram for finding relative humidity by inspection from the readings of the wet-and-dry-bulb thermometers. The writer regrets that he is unable to state how far Mr. Russell's diagram resembled the hygrograph. Doctor Spring, in 1894, devised a movable scale, which, when adjusted to pass across the tops of the mercury columns of the two thermometers, allowed the dew point to be read off.

Sir R. Strachey also invented a slide rule to give relative humidity, this being of some interest to the writer, as his own first efforts were toward perfecting a form of slide rule, which was afterwards abandoned in favor of the chart.

A Mr. Galton went further still; he invented a machine to make the reduction of hygrometer readings mechanically.

In 1906, Dr. John Ball described some sets of scales, drawn on cardboard, which among other things, allowed relative humidity to be determined. The set dealing with relative humidity consisted of three scales, lying at angles to each other. The dry-bulb scale was curved, and wet-bulb scale straight, and the humidity scale slightly curved. A straightedge, either of wood, or, preferably, consisting of a strip of transparent celluloid, with a straight line scratched on its under surface, formed a necessary part of the equipment. To make use of the arrangement, the straightedge was adjusted so as to pass through the points on the wet-and-dry-bulb scales indicating respectively the thermometer readings; the intersection of the straightedge, so placed, and the humidity scale then gave the percentage saturation.

*Head of Mining Department, Heriot-Watt College, Edinburgh, Scotland. Vol. XXXV, page 54, Transactions Mining Institute of Scotland.

A better-known instrument, called the "Hygrodeik," also designed to avoid the use of tables, is on the market.

Mr. Henry Davis records a trial that he made to construct a chart from Glaisher's tables, and stated that he had abandoned the attempt, as he thought a chart of the kind would be unwieldy and difficult to read underground.

After the writer had worked at the question for some time, it became evident to him that if such a chart was to be at all successful, it must consist of straight, and not curved, lines, as the latter are difficult to follow with the eye; also, that, if possible, it ought to be free from anything in the way of a moving straightedge or pivoted pointer. He also thought it best to leave out of consideration all designs in which the actual graduations of thermometers played a part, owing to the difficulty experienced in obtaining thermometer stems of absolutely the same bore.

By making the scale of "percentage saturation" uneven, in the manner shown, the writer found that the inclined lines (which otherwise are in the form of sagging curves) straightened out; and, further, by placing the inclined lines at a small angle to each other, instead of parallel, that the upright lines also became straight.

The hygrograph may be obtained, engraved on aluminum or on silvered brass, either attached by screws to the face of an ordinary hygrometer, or separately, in a thin leather case. The latter form will be useful to those who prefer to reduce hygrometer readings in the office, and also, perhaps, as a pocket instrument, to inspectors of mines and factories.

Canadian Mining Institute Meeting

The seventeenth annual meeting of the Canadian Mining Institute will be held in Toronto, March 3, 4, and 5. An interesting program is assured.

Mine Gases

Some New View Points on the Origin, Occurrence, and Behavior, of the Gases Usually Found in Mines

*By Frank Haas**

SO MUCH has been written about mine gases that it would almost lead one to believe that the subject was exhausted; but read much as we will, we find that there are constantly things coming up which appear new and give rise to a new line of thought.

It is the purpose, in the course of this paper, to discuss some phases of this mine-gas question which, to us at least, have not been brought out very plainly in the past literature on this subject. However, such statements as may be made must be taken guardedly, not that they do not express the facts as we see them, but because of conditions elsewhere, the interpretation of the observations may be widely different. It is to the local conditions that we may attribute the various and widely different opinions, not only as to the formation but the occurrence of mine gas.

The Gases and Their Origin.—You are all probably familiar with the ordinary gases that are found in mines after gas or dust explosions, mine fires, and spontaneous combustion, therefore air, methane, carbon dioxide, carbon monoxide, and water vapor will suffice for practical discussion. It would probably be well to know, however, that were we to go into extreme refinement the gases actually present are almost innumerable. For instance, the gas known as nitrogen consists not only of nitrogen, but also an appreciable amount of argon and minute quantities of metargon, aetherium, krypton, neon, xenon, helium, and others, all of which are equally or less inert to chemical reaction than nitrogen, and can therefore be classed as such. Then again, methane, particularly when produced by coal-dust explosions, is accompanied by various other hydrocarbons in a series so long that probably all have not yet been identified. Then there is ammonia, the various compounds of sulphur and phosphorus in oxydized and volatile forms, and many others. But most of these can be grouped with the four given and the others are insignificant.

With air, we are most familiar. The authorities are agreed that its composition is practically uniform throughout the world and that it is composed approximately of 79 per cent. nitrogen and 21 per cent. oxygen. Exception to this will be taken in the discussion of the origin of carbon dioxide in which it will be assumed that air contains .04 per cent. of carbon dioxide at the expense of oxygen.

The physicians tell us that in normal respiration the air which is thrown from the lungs contains about 4 per cent. of CO_2 and about 17 per cent. of oxygen. From this it would appear that with 17 per cent. or less of oxygen in an atmosphere it becomes oppressive to animal life. How much more this could be reduced without fatal results is problematic, possibly depending on the man's condition and the exertion he is undergoing at the time, but the authorities agree that below 10 per cent. life could not long be maintained. These percentages would probably be altered, depending on whether carbon dioxide, nitrogen, or methane takes the place of oxygen.

Air is the principal carrier of water vapor in mine atmosphere, but since water vapor is not considered a permanent gas at ordinary temperatures and pressures, it is never reported on a percentage basis where gases are expressed by volume. Air has the property of carrying variable quantities of water vapor, which is an important

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feature but will not be discussed here.

Carbon Dioxide.—Carbon dioxide in mine air has many sources and occurs in variable quantities. The air is originally supposed to contain .04 per cent. of carbon dioxide. This is increased by the breathing of men and animals, from lamps, fumes of explosives, and from putrefaction, fermentation, decomposition of wood, minerals, and excrement of man and beast. In an ordinarily ventilated mine these latter sources are comparatively small and probably would not amount to more than .02 to .03 per cent.; this makes a total of .07 per cent. which may be expected to be encountered in any mine and is too small in amount to be of any consequence whatever.

There are several causes or sources which may be considered local or unusual, in that they do not occur in all mines. The infiltration of water carrying carbonated waters, which give up their carbonic acid gas when they come in contact with the acid waters of the mine, and the solution of calcite or carbonate of lime in such water, would evolve carbon dioxide. This calcite is of very common occurrence in coal seams and has been known to exist in layers 2 or 3 inches thick. Combustion or explosion of methane or coal dust forms large volumes of this gas. Spontaneous combustion of coal, or any other material, will produce carbon dioxide. Occluded gas in coal may add some little carbon dioxide.

There is only one natural means by which the carbon dioxide may be reduced in the mine. This gas is comparatively soluble in water, and if it comes in contact with water not acid it will be absorbed from the air and remain in the water. The quantity so absorbed will depend on the minerals already in solution in the water and the temperature.

What interests the mine foreman is, how much carbon dioxide may be tolerated in mine air, no matter where it comes from, and not be injurious to the health or efficiency of men and live stock. Here we run into a multitude of opinions, and they vary from .1 per cent. as unfit for human consumption, as expressed by a hygienist, to the other extreme who says that 10 per cent. is not fatal. It is fairly well agreed, however, that when 4 per cent. of carbon dioxide is reached it shortly becomes uncomfortable. This is about the same as the percentage in the exhaled breath of a human being. The most reasonable opinion is that of the German engineer who states that nature's warning is the best criterion and puts the limit at 3 per cent., anything less is tolerable and anything more is for the physiologists to quarrel over and does not concern the miner.

In regard to the wide variation of the opinions expressed, each one may have been correct but the authors failed to describe the conditions under which the experiments were made and the relation of other gases that composed the total mixtures. It is vastly different whether the tests are made in stagnant atmospheres or in currents, and whether the carbon dioxide replaces the oxygen or the nitrogen or both, or whether other gases are present. The same controversies and misleading results have taken place in the question of how much carbon dioxide will extinguish a flame. This latter question has been so admirably handled in a previous paper in our transactions by Mr. G. A. Burrell (1912 Volume) that it is unnecessary to dwell on it here. His conclusion is that 4 per cent. of carbon dioxide will extinguish a flame under all conditions that may be encountered in a mine.

To the practical miner, put in the simplest form, it means this: "If your oil lamp starts to fail you or breathing is uncomfortable, your working place is intolerable, a condition anything worse is dangerous."

However bad the effect of carbon dioxide in the mine atmosphere, it is doubtful whether it has ever been the primary cause of a single death of a miner in our state, from the fact that dangers of greater magnitude invariably accompany it, and it may be considered the least dangerous of all gases encountered.

Carbon Monoxide.—In this gas the miner may well recognize his greatest danger. Fortunately it does not exist in our mines when conditions are normal, excepting only the small quantity produced by explosives.

The sources of carbon monoxide are few and then only under exceptional conditions. From its chemical formula, it would be naturally inferred that it was a partial combustion of carbon with oxygen, strictly speaking however this is not the case. Carbon monoxide is not the result of the combination of carbon with one atom of oxygen, but it is invariably formed by the reduction of carbon dioxide by losing one atom of oxygen to other elements which have a greater affinity for oxygen under the existing conditions.

There is an impression, probably a common one, that when methane burns or explodes with insufficient oxygen for complete combustion, carbon monoxide is one of the resulting products. This is in error, and there is no danger of the formation of carbon monoxide from the explosion of methane. Unfortunately there is no such thing as a pure methane explosion in coal mines, as there is always some coal dust present, which, when affected, alters the results entirely. An explosion of coal dust, either with or without methane, will produce considerable quantities of carbon monoxide and this is the principal source of this troublesome gas.

Mine fires and even spontaneous combustion will also produce carbon monoxide in considerable quantities. It is very questionable whether the occluded gases of coal add any appreciable quantity, first from the question whether any occluded gases are liberated, and again that, if so, they probably do not contain any carbon monoxide.

The quantity of carbon monoxide given off by explosives (black powder for instance, which is the great-

est offender is negligible from a ventilation standpoint. If it were possible to hold undiluted the gases given off by the explosion of black powder, the carbon monoxide would probably represent 18 per cent. of the total. But the amount is so small and dilution with air so rapid that the result is almost insignificant. A pound of black powder will generate about 1 cubic foot of carbon monoxide gas. In all probability much of this is burned subsequent to the explosion. Numerous cases are reported of miners being burned by setting fire to gases when examining the results of a freshly fired shot, and this has been attributed to the presence of carbon monoxide. This we believe to be largely in error; the probabilities are that the intense temperature of the explosion distilled some of the surrounding coal, and the inflammability of the gases is chargeable more to the hydrocarbon gas than to carbon monoxide, at least the appearance of the flame would indicate this.

The advice to the practical miner in regard to the danger of carbon monoxide is this: In an ordinarily ventilated mine with no abnormal conditions, there is no danger from carbon monoxide. In mines in which there has been an explosion of any kind, where a mine fire is in progress, or where spontaneous combustion is known to exist, he will take it for granted that carbon monoxide is present in the ventilating current. There is no remedy to apply except an abundant air supply. There is no percentage of tolerance, as the poisonous effect is cumulative and the smallest appreciable percentage will in time result fatally.

Standing bodies of carbon monoxide frequently referred to in articles, and even in textbooks, are purely a myth. From the very nature of its formation the suggestion of such a thing is absurd. Safety lamps are of no use with carbon monoxide. The man who has found carbon monoxide with a safety lamp in a mine under actual conditions does not live to tell about it. Even with a helmet, other conditions would put a man's lamp flame out of commission before this point is reached. It is only in artificial atmospheres where tests with safety lamps can be made.

Methane.—Methane, firedamp, marsh gas, or simply gas (all misnomers except the first) has probably been discussed more than any single phase of the coal mining problem. Its properties are so well known that there need be no discussion of this feature here. There is, however, something to be said about its source and its mode of occurrence in the mines. Most of the literature on this subject has emanated from European countries where it has been studied since coal mines were first opened. The general impression which we get from these writings, and it has been largely copied into our literature on the subject, is that methane originates in the coal seam and that coal is the exclusive source of this gas. The reasoning as far as it goes is apparently sound. All coals contain more or less gas, of which methane is the principal one; it is liberated as the coal is opened, therefore the gas comes from the coal. But why not apply it to water; the analysis of coal shows that it contains water, and when the coal is mined water is encountered; will any one say that all water is found in coal seams?

Let us quote from Caleb Pamely's "The Colliery Manager's Handbook," 5th edition, considered one of the best mining books in England, just to show what this authority has to say on the source of methane: "The origin of this gas (methane) in coal is the change which has produced coal from vegetable matter. It is probable that during the process of decomposition, new strata accumulated to such an extent as to cause considerable pressure. Where these newly deposited strata were of a porous nature, the gases given off during decomposition would escape through the strata to the surface, but where the cover over the buried vegetable matter was impermeable, the gases were retained at increased pressure as decomposition proceeded and the coal seam fully matured. Most probably the gas is contained in coal seams as water is in a porous rock, and remains there in a more or less compressed condition so long as the enclosing walls are gas tight and able to withstand the pressure from within. Probably the coal is still in a state of chemical change or decomposition, which may be proceeding very slowly, and thus gases are continually evolved and accumulated within the pores of some coals," and so on.

Now if this is all true, why do not all coal mines give off gas to a certain extent at least? How will we explain the fact that of two mines side by side and practically of the same size, in the same seam of coal and all conditions apparently the same, one of these mines gives off half a million feet of gas per day and the other practically none.

Now let us see what Germany has to say. There was published in 1903 a treatise composed of some twelve volumes; the contributors were the best authorities at the time, and was known as "Die Entwickelung des Niderrheinisch-Westfalischen Steinkohlen-Bergbaues" and which was considered the "last word" on coal mining in Germany. After discussing the question of mine gases over several hundred pages, in which mines and districts are classified, seams are classified, depths from the surface, kinds of coal, and in fact every imaginable combination is made to indicate why certain coal mines have gas and others have none, in a vain attempt to bring it all to some reasonable conclusion, they end with a sentence which translated means "it should not be overlooked however that there may be other sources of gas besides coal seams, since gas has been encountered in sinking shafts and it has also been found in salt and strontia mines." So with this short brief statement other sources of methane are dismissed. A later book, also German, by Wabuer, an excellent

treatise on ventilation, passes the matter still more lightly, and even goes so far as to say that the gas escapes from the coal to the adjacent strata, and, probably to fit the theory, states that methane is seldom found in anthracite mines.

In Belgium coal is also charged with being the source of methane. In that country the coal measures are very much disturbed geologically, with faults, folds, and overthrows; there is one instance where the Devonian limestone has pushed over the coal measures for a distance of 30 miles. In disturbances of such magnitude there must necessarily have been formed cavities subject to enormous pressure. It is here that they have the great outbursts of gas, pressures as high as 800 pounds to the square inch are recorded; the wonder is that they don't get higher pressures than this under such conditions.

We might add to those some American publications, even textbooks, which lean largely to this generally accepted theory.

However, the object of this paper is not intended for a criticism of others' opinions in other parts of the world, but to point out plainly that here in West Virginia methane does not have its source in the coal. Our coal seams are porous and like other porous stratifications are simply a reservoir for the so-called natural gas which has its source far below the coal seams. If we are correct in our opinion on this source of the gas in our coal mines, it should aid us not only in anticipating the flow of gas from our mines but also in the manner of handling them.

In our experience in West Virginia we have never yet found it a rule that the gas comes from the top, the bottom or from the coal itself; it is liable to come from anywhere or everywhere at once. Feeders from the bottom can with reason be expected to have longer activity than those from the top and this is also borne out in practice. While the gas which originates from the bottom of the seam is the larger portion of the total gas encountered in the mine, it is the easiest to handle.

Every mine which has encountered methane in quantity and naturally anticipates more, carries (or at least should) its ventilating current to the face of the coal. The gas escaping from the bottom, with its natural tendency to rise due to its lesser specific gravity, mixes readily and thoroughly with the air-current. At this point it would be well to call attention to another laxity of expression. We have seen it stated innumerable times that "methane due to its low specific gravity has a tendency to rise and collect at the roof of a mine." This is true, but to this statement should be added "but when mixed with air either mechanically or by diffusion this tendency is completely eliminated." Gases once mixed will never separate, irrespective of their specific gravities. It has been tested out frequently that bottom gas mixes very rapidly, and in a comparatively short distance from its origin the percentage of methane is practically uniform through the area of the entry.

Bottom blowers, or feeders, are usually encountered in the heading or entries. Entries are usually in advance of room works, and as these feeders develop along certain lines the entries usually encounter them months, or probably years, before the room work is sufficiently advanced. It appears that these blowers follow well-defined fissures or clay veins.

Blowers from the roof, while not so consistent or continuous in their flow, give rise to an entirely different problem. In entry work they are easily handled, but when rooms are driven in more or less stagnant air, accumulations of gas may and do form and give the fire boss a chance to earn his pay. When pillars are drawn back and roof falls occur, the ventilating current becomes more and more reduced on such gob piles as the excavated area becomes larger, and finally high on these pillar falls the current fails entirely and there is nothing to prevent a constantly accumulating body of gas from forming. Diffusion has proceeded until equilibrium is reached and there remains that unpleasant sensation that a large body of gas is above and that it will come down some time, either with a rush or gradually, as the conditions and circumstances dictate.

A pillar fall breaking to the surface may be woe to the farmer but it is joy to the pit boss for this is the only natural way in which his danger can be removed.

Nearly a year ago the Consolidation Coal Co. had a particularly aggravating case of this kind. The pillar fall was not of sufficient size to hope for a surface break for a long time to come. The gas frequently and persistently came down at unexpected times, due to multitudinous causes which defied correction. Each offence required either a shut-down or a night shift to clear matters up and became a matter of no small expense. It was finally decided to put down a drill hole from the surface to tap this body of gas and see what would happen. The hole is still in operation 9 months after drilling in and still doing its work successfully. While at first the escaping gas was nearly pure methane the percentage rapidly dropped off and after a week's time and since, the percentage has been fluctuating between 3.5 and 10 per cent. For future reference and information various observations were continuously made. One feature that was particularly interesting was that nitrogen (other than normally with air) or blackdamp was also constantly discharged, but there was apparently no relation between the two. Blackdamp was not anticipated in large quantities and its existence was first suspected when we found that a 9-per-cent. mixture of methane would neither explode nor burn. A complete analysis of the gas clearly showed why. It was a case of deficiency of oxygen. This subject has been worked out in part by the Bureau of Mines, only (so far as I know) they have devoted their at-

tention more to carbon dioxide as the inert gas.

Bore holes as a solution for gob gases have their limitations, however; in a case where the surface subsides without a surface break the problem is very much complicated. In such cases it will require one's best judgment reinforced by a liberal amount of luck in order to find the proper location for the hole.

The question of how much methane may be tolerated in mine air is a very difficult one to answer. But, however much we should like to avoid an answer, it is essential that some line be drawn, particularly where ventilation follows a control by chemical analysis. We have made it a rule that the return in any individual split or in the main return air-course there shall not be more than .3 per cent. methane. This gives a factor of safety of about 17, which we believe will more than take care of any contingency that is probable or likely to occur. This is considerably less than has been suggested by the mining laws of Pennsylvania and the United States Bureau of Mines.

The time is past when the miner need fear a mysterious danger from firedamp. The laws which govern its actions under all circumstances are so well worked out that all mystery is dispelled.

When you have a foe before you it is well to know his strength, and without belittling his power to know his limitations also. Confidence is necessary in the face of danger, but remember that your ability, industry, and confidence, will gain you nothing if that eternal vigilance is not uppermost in all your endeavors.

To William Murdock belongs the credit of first applying gas distilled from coal to purposes of practical utility. He is said to have filled bladders with gas and used it for lighting his way across the Cornish downs, and to have occasionally scared the miners by giving an extra squeeze to the bladder and projecting a long flame.

The Sorehead

Written for The Colliery Engineer by R. T. Strohm

He's never contented, no matter how squarely
  His company's business is done,
But always is ready to censure unfairly
  The methods by which it is run.
Although by his talk you would judge he had striven
  To learn what is newest and best,
Each time that a chance for improvement is given
  He hasn't a thing to suggest.

The higher officials and board of directors
  Come under the ban of his curse;
He calls them a parcel of money collectors,
  And pirates, and harpies, and worse.
He swears that their souls are so puny and narrow,
  Their hearts are so little and hard,
They'd open the bones of a gnat for its marrow
  And render its hide for the lard.

He stoutly maintains that the mine of a neighbor
  Gives better conditions and pay,
But strangely enough sticks so close to his labor
  That no one can drive him away;
Yet while he is working, he loses no chances
  To generate strife and debate,
And seizes on any and all circumstances
  To stir up resentment and hate.

So, while he continues to pocket his wages
  From those who accept his employ,
He stoops to the tricks of the knave and engages
  In acts that obstruct and annoy;
Yet doubtless if some one should brand him as graceless,
  And call him a treacherous sneak,
He'd bluster and vow such assertions were baseless
  Or prompted by envy and pique.

Steel Mine Ties

Occupy Less Height in Low Coal, Furnish More Reliable Track, Give Longer Service Than Wood, and Are Easier to Lay

Written for The Colliery Engineer

STEEL ties have been in use many years on the larry tracks of coke ovens, where they are subject to more severe strains than they would receive in mines, yet they are little used in main haulways.

During the past 6 or 7 years or since the Fairmont Machine Co. entered into the manufacture of steel mine ties as a business, many companies have adopted them in place of wooden ties, one company alone, the Delaware, Lackawanna & Western, having ordered in a short time 46,000; another, the Hutchinson Coal Co., has 45,000, while the three coal companies in which J. E. Wilkenson, of Philadelphia, is interested have 41,000 ties in use. Such companies as these would not order steel ties by the carload if they did not possess merits that made them equal or better than wooden ties, besides more economical.

In most coal mines it has been customary to use split wooden ties in rooms, few making use of faced ties. These are able to hold the track only when they are not roughly triangular in shape; however, some ties of this objectionable shape do appear, and half-round ties split readily, so that possibly one tie in every ten is merely good for cord wood. When dressed ties are used their cost in place will range from 5 to 12 cents in favorable localities. Room ties are placed about 3 feet apart and light rails are used. They are not tamped so as to make a firm road bed, and owing to the unevenness of the floor and varying thickness of wooden ties a loaded car rocks and throws its weight against one rail which of course loosens the small 2½- or 3-inch spike. In a short time this action spreads the rails and a car becomes derailed with the result that a hunt must be made for levers and bait to put it back on the track, or some one must go for a car rerailer, and a mule; in either case valuable time is lost by the company and miners. Oftentimes this derailment bends the rail downward between ties by the weight of the loaded car, and these two features call for additional expense. Although spikes used in rooms are small, they are oftentimes large enough to split the ties and two are frequently required on one side and sometimes on both sides of the rail; in addition to this a number are lost in the gob and some are bent so as to be worthless, especially when being pulled in order to loosen and remove the rails. Where wooden ties are used, every fifth tie must be faced so as to take and support the joint even when fish-plates are used; also experienced trackmen with tools are required to lay the track toward the face. These men carry the rails, tools, and spikes, and while it is usually customary to figure spikes at 1 cent per tie, so many are lost that 1¼ cents per tie would be nearer correct. Split wooden ties may be used from one to six times, but more often once or twice because they are attacked by dry rot and lose their holding power on the spike, or because they dry out and split when an attempt is made to relay them.

Fig. 1. Steel Ties on Machine Track

In nearly every case where an attempt is made to analyze the cost differences between wooden and steel ties, the results in one way or another favor the steel ties. Among the advantages claimed by users of steel ties are the following:

Their cost is less in the long run than wooden ties, because steel being more durable, it is possible to use the ties over and over again.

No spikes or fish-plates, bolts, or nuts are required, items which save time and money, either when laying or removing the rails.

The steel ties form their own roadbed; and, the rail being practically on the floor, the track soon becomes smooth and firm, keeps true to gauge, and as there is less bending there are fewer derailments of cars. In case a car does leave the track, there is a lift of about 2½ inches to place the wheels on the track compared with 6 inches in the case of wooden ties; and further the rails are not distorted nor do they have to be respiked before the track can be used.

Steel ties being light, one man can carry four with almost the same effort as one wooden tie, therefore they are preferred by miners who will lay their room track in preference to waiting until the regular trackmen can come to do the work, as in cases where wooden ties are used.

Miners are more careful in removing steel ties when doing pillar work, because they are easy to unfasten from the rails, no spike puller being required, besides they can pick them up with one hand and carry them to safety.

This quick laying and removal of the Fairmont steel tie aids in many instances in the recovery of rails where wooden ties would prevent their recovery if quick action were demanded.

If steel ties become bent or broken they are easy to repair, therefore since they are neither lost, worn out,

nor scrapped to any appreciable extent, they become an asset and a credit in the inventory. Only wooden ties that have never been laid are an asset in a mine inventory.

The following data*, taken from the Transactions of the 1913 West Virginia Mining Institute, relate to the Kirkwood mine of the Hutchinson Coal Co., near Bridgeport, Ohio. The seam worked is Ohio No. 8 corresponding to the Pittsburg bed farther east, and is 5 feet 4 inches thick. The statement gives the cost of hauling coal on all-wood track in rooms in 1907—75 per cent. steel track in rooms in 1908 and all-steel track in rooms in 1909.

Year 1907. All-Wood Track

Month	Tons Produced	Cost Per Ton
September	16,043	.0480
October	26,216	.0402
November	22,617	.0370
Average cost per ton		.0410

Year 1908. 75 Per Cent. Steel Track

Month	Tons Produced	Cost Per Ton
September	12,620	.0398
October	16,696	.0336
November	16,281	.0321
Average cost per ton		.0348

Year 1909. All-Steel Track

Month	Tons Produced	Cost Per Ton
September	21,556	.0284
October	22,540	.0281
November	25,191	.0282
Average cost per ton		.0282

Saving per ton in favor of all-steel track	.0128
Saving for 3 months of 1909	$886.85
Saving per room, 24 ft. × 200 ft., coal 5 ft. 4 in., 1,000 tons	12.80

Table 1 shows a comparison of cost of removing the coal from a room 24 feet wide, 200 feet long, 5′ 4″ thick, by the use of steel rails with wood ties and steel rails with steel ties which was also made at the same time.

Up to this point the relative comparison between wooden and steel ties in thick coal beds has been considered, whereas in thin beds the steel tie possesses all the advantages mentioned and more which make them valuable adjuncts to coal mining.

Table 1

Wood Ties		Steel Ties	
Ties 2½ feet apart, 80 ties at 12 cents	$ 9.60	35 ties at 33 cents	$11.55
320 spikes, 40 pounds	.90	Labor removing track (Track laid by miners)	1.50
Labor laying and removing track	7.50	Depreciation	1.00
Depreciation of ties and spikes	3.50		
Total	$21.50	Total	$14.05
Value of material left	7.00	Value of material left	10.55
Actual cost	$14.50	Actual cost	$ 3.50

Saving per 1,000 tons, $11, or .011 per ton.

In low beds, small cars must be used; however, steel ties will allow from 4 inches to 6 inches more headroom than wooden ties. This permits of a larger car, or more load, and will in some cases do away with brushing the roof or floor.

C. H. Meade, general manager of the Peytona Block Coal Co., in West Virginia, found that where he had to widen the roadway to 6 feet when using 5-foot wooden ties, by using steel ties he reduced the width to 4 feet, and as the height of the tie was ½ inch compared with 4 inches, the lessened work in taking up bottom slate amounted to 58 cubic feet in every hundred feet.

As tracks are comparatively easy to lay, wooden wedges being used to hold the rails, only a horizontal blow is needed, where with wooden ties it is often difficult to strike a vertical blow and drive the spikes properly. One of the chief values of steel mine ties is the ease with which rails may be advanced toward the face.

The Jeffrey-Drennen coal cutter shown in Fig. 1 has a sweep of 21 feet and weighs 7 tons. It is used at Fleming, Ky., on steel ties which is an evidence that such ties may be subjected to great strains and still hold a firm track. In this case the jumper rail is turned upside down as shown to the left of the cut, which is considered to be better than laying it on its side, and further it is held in place by a steel tie. There seems to be no question but that this tie is suitable for main haulage roads, is a labor saving and a great addition to economical mining, besides saving the timber used in wooden ties for other purposes. While sulphur water has some appreciable effect on steel ties, the same as on steel rails, it nevertheless has to be high in acid to cause corrosion.

Anthracite and Bituminous Production, 1914

The Bureau of Anthracite Statistics states that "if the quantity of anthracite sold to local trade and employes be put at 3 per cent. of the shipments—a proportion that has held approximately, in recent years —then the total marketable output in 1914 was 70,352,050 long tons, as compared with 72,052,926 tons in 1911 and 71,141,717 tons last year. This does not include the coal used in the operation of the mines themselves which is equal to 12 per cent. of the quantity shipped." The estimated production by the United States Geological Survey is 81,718,680 long tons. It is probable that when the two sources of information have balanced their accounts their figures will approximate. The Bureau of Anthracite Statistics does not include the shipments over the Lehigh & New England Railroad of the Lehigh Coal and Navigation Co.

According to the tentative figures of the United States Geological Survey, the production of coal in 1914 was 510 million short tons, a decrease of 60 million tons compared with 1913. It is estimated that bituminous coal in Pennsylvania decreased between 20 and 25 million tons from production in 1913 which in that year amounted to 173,781,217 short tons.

*Official obtained by J. Clark Evans, Fairmont, W. Va.

OBITUARY

THOMAS LYNCH

Thomas Lynch, president of the H. C. Frick Coke Co.; the Bunsen Coal Co., of Illinois; the United States Coal and Coke Co., of West Virginia; and three smaller Pennsylvania corporations, the Sharon Coal and Limestone Co., the Republic Coke Co., and the Hostetter-Connellsville Coke Co., died at his residence in Greensburg, Pa., on December 29, 1914.

Mr. Lynch was born at Uniontown, Pa., on August 13, 1854. His parents were natives of Waterford County, Ireland, who came to this country shortly after their marriage, his father being a contractor. He attended school until he was 17 years of age and then began business life as a clerk in a store. In 1875 he first became associated with H. C. Frick, who was at that time just fairly started in his career as a coke operator. His first position was that of a clerk in the H. C. Frick & Co. store at Broadford, Pa. In 1877 he was made superintendent of the Valley coke plant and store when it was leased by his employers.

In 1882, the firm of H. C. Frick & Co., which had grown to be the most prominent firm in the Connellsville coke region, was incorporated as the H. C. Frick Coke Co. In the same year he was appointed general superintendent of all the company's operations.

From that time on, the H. C. Frick Coke Co., with Mr. Frick as its executive head, and "Tom" Lynch, as he was familiarly called, as chief of its operating department, grew rapidly into the dominating position in coke making that it has held for many years.

Mr. Lynch's services to the company were such that in 1890 he was made general manager, and in 1896, when Mr. Frick retired as president, he was elected to succeed him.

As president of the H. C. Frick Coke Co., he was more than an executive to preside at board meetings and to exercise a very general su-

pervision of the company's business. He chose competent subordinates, always kept in touch with them, and consulted them in matters pertaining to the various mining and coking operations. He had a kindly disposition, but when occasion demanded he was as firm as a rock. In business or labor disputes he held strenuously to what he believed was fair and right, and when a matter was settled he never held resentment.

This trait of his character was strongly shown some years ago, after a series of long and bitterly waged strikes in the Connellsville region. He would not yield a particle from his position in those contests with the mine and coke workers. After the strikers were beaten and they returned to work, he voluntarily pledged fair wages and fair treatment to all the mine workers of the Frick Coke Co. That pledge he kept to the letter. He took a keen personal interest in the welfare of the mine workers, and for many years the relations existing between the H. C. Frick Coke Co. and its employes have been remarkably and continuously friendly.

He was the originator of the "Safety First" movement. In 1892 he framed a set of mine rules to supplement the State Mine Laws, and adopted the phrase "Safety the First Consideration" as a watchword for the officials and all employes. These rules he improved from time to time, and those now in force are recognized in all mining fields as being most rational and efficient.

His interest in the safeguarding of mine workers was forcefully shown on one occasion when, in addressing a group of mine officials and explaining some safety rules he had framed, he said: "The H. C. Frick Coke Co. doesn't own a mine worth as much as one human life. The flippant and so-called humorous saying that 'it is cheaper to kill a Hunk or a Wop than a mine mule' doesn't go in our organization. The Slav and the Italian are human beings entitled to as much protection as you or I."

The safety measures and the welfare and sociological work of the mining companies over which he presided have been frequently illustrated and described in The Colliery Engineer and other periodicals.

While a man of strong opinions, he was very tolerant, and respected

the honest opinions of others. In religion he was a Roman Catholic. He respected the religious opinions of others and quietly and unostentatiously encouraged work of other denominations among his employes. When a wealthy Greensburg man who died a few years ago bequeathed a large sum of money to the Greensburg Y. M. C. A. for the purpose of erecting a building for its work, he named Mr. Lynch as one of the trustees to carry out the terms of the bequest. This trust Mr. Lynch accepted, and he gave much time and consideration to it until the building was completed and turned over to the association.

He was married on December 16, 1879, to Miss Sarah Agnes McKenna, of Pittsburg, who with the following sons and daughters survive him: Mrs. Jos. D. Wentling, Miss Sarah A. Lynch, Thomas Lynch, Jr., Ralph Lynch, H. Clay Lynch, and Charles McKenna Lynch, all of whom but H. Clay Lynch reside in Greensburg. The latter, being general manager of the Bunsen Coal Co., resides in Danville, Ill.

ROLAND Y. LUTHER

Roland Y. Luther, general manager of the Peerless Coal and Coke Co., of Vivian, W. Va., died at the University Hospital, Philadelphia, on January 4. Mr. Luther was a son of the late Roland C. Luther, a distinguished mining engineer, who for many years was general manager of the Philadelphia & Reading Coal and Iron Co. He was born in Pottsville, on January 23, 1876, and was educated in the public schools of his native town, and at Andover, Mass. About 12 years ago he went to West Virginia as assistant manager of the operations of the Peerless Coal and Coke Co., in which corporation his father was financially interested. After his father's death he was elected vice-president of the company, and in May, 1910, became its general manager.

Mr. Luther is survived by his wife, who before her marriage was Miss Grace Lewis, daughter of the late Daniel Lewis, a former prominent mine superintendent in the Schuylkill anthracite field, his mother, and one brother, Edwin C. Luther, a civil and mining engineer, of Pottsville, Pa.

Composite Mine Props

A complete mine prop, designed by John Kirkby, of Pilsley, Chesterfield, England, and in use at a leading colliery in the Midlands for over 3 years, is an interesting innovation in mine timbering. Fig. 1 shows sections and dimensions of the more usual sizes and is self-

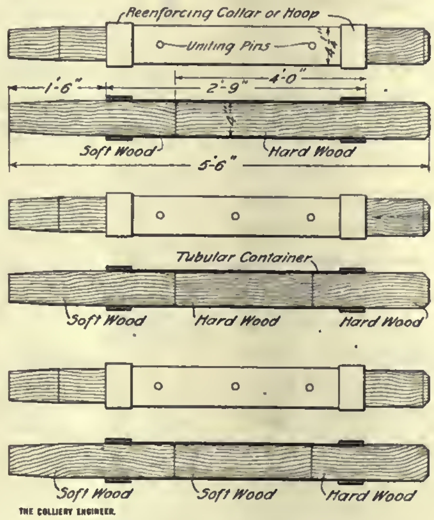

Fig. 1. Composite Mine Props

explanatory. The initial cost is low especially if the colliery happens to have a stock of old steel pipes of suitable size such as are used for conveying water, steam, or compressed air and these will be amply strong when they are no longer suitable for their original purpose. The chief advantages claimed for these composite props are: that they are lighter than an ordinary wood prop of the same length and considerably stronger; that they more nearly approximate to the wood prop in shape and are consequently more liked than the other forms substituted for the wood prop; that they are adjustable in length as a supply of the "soft ends" can be kept in the stall varying in length, say from 2 inches to 6 inches from the standard adopted and it is only a matter of moments to insert one of a suitable length; that they are safe props, as the soft ends giving away first afford the miner an opportunity of knowing how much weight is upon the prop, and the reinforced central portion being of much greater strength, will not buckle and collapse without giving warning of such collapse as do the ordinary wood props and other substitutes of like nature where the strength is the same at any portion of the length; they are more economical than any other form of pit prop, as in actual use they can be set a greater number of times without necessitating a new soft end while the other portion is practically everlasting.

As an illustration of their low cost, it may be mentioned that at one particular colliery a number of these props had been in use for over 3 years, the soft ends costing 1 cent each for timber and manufacture, some being reset four and five times with the same ends. They are essentially room props, but there is no objection to their use elsewhere provided that there is an opportunity of recovering them. At the colliery mentioned, not one prop was lost in 3 years. A number of experiments have been carried out with these props giving particulars as regards their strength, and the weight borne by them during use; such being obtained by introducing lead cylinders of known sizes between the wooden props and measuring their compression when the props were withdrawn.—*Coal and Iron Trades Review.*

Methane, CH_4

Methane, CH_4, is found in natural gas, coal mine gas, and is obtained from the distillation of coal. It is the chief member of the paraffin series of hydrocarbons. It is said to liquefy at no amount of pressure above a temperature of $-81.8°C$. It boils, according to Ramsay, at $-160°C$. Its specific gravity compared with air is .559, and 1 cubic foot of the gas weighs 312.36 grains at ordinary temperature and pressure.

WITH THE EDITORS

IN TESTIFYING before the Industrial Relations Commission, Miss Ida Tarbell is quoted in press dispatches of January 19 as "cheerfully admitting that even at the present time women, stripped nearly to the waist, stoke coke ovens in Pennsylvania and other states." If Miss Tarbell has been correctly reported, and is not already a member of the "Ananias Club," she is now qualified for full membership in that organization.

THE prosperity that has been the good fortune of the anthracite fields of Pennsylvania for some years past seems to have had an irritating effect on some of the alleged statesmen at Washington. Their ignorance of actual conditions existing in mining regions, plus a pig-headed determination not to recognize facts as they exist, offer the only excuse for most of the legislation and official meddling in both anthracite and bituminous coal mining operations. If instead of sending committees of politicians or department clerks, absolutely ignorant of the technical and commercial sides of coal mining, to investigate and report on conditions in various fields, some of the competent men connected with the Bureau of Mines were used, there is a bare possibility that a little common sense would filter through the ivory domes of some of the recipients of Congressional salaries sarcastically referred to as "Solons."

The Law Regarding Hoisting Engineers

A REMARKABLE case involving a question of mine management was tried in the criminal court of Schuylkill County, Pa., last month. It resulted in the conviction of James B. Neal, manager of the Buck Run Coal Co., upon four charges of violating the 8-hour law of 1911, as applied to hoisting engineers.

The remarkable feature of the case was that the complainants who made information against Mr. Neal, and that gentleman, showed no feeling in the matter except an extremely friendly one. The facts of the case were that Mr. Neal changed the working hours of the engineers from three shifts of 8 hours each per day, to two shifts, one of 10 and the other of 14 hours. This change applied only to those days when the mine was idle, and only an occasional trip was to be made. At other times he complied with the law. When objection was made to the change, Mr. Neal, who believed he had a legal right to make it, suggested that a test case be made. This was agreed to, and it resulted as stated above. Judge Brumm, who presided at the trial, imposed the minimum penalty of a fine of $25 and costs on Mr. Neal in one of the four cases, and suspended sentence in the other three. Mr. Neal and his prosecutors left the court room together in a most friendly mood, and the latter resumed their work with a most kindly feeling prevailing between them and their superior officer.

Thomas Lynch

THE portrait of Thomas Lynch, shown in connection with his obituary on another page, is an excellent one in that it shows the features of a man of force and strong character. But it fails to show his kindly disposition, his pleasant smile, and the many characteristics that endeared him to his subordinates and personal friends.

His death, at the comparatively early age of 60 years, was not only a great loss to the corporations he so ably presided over, and to his personal friends and acquaintances, but it was a loss to the coal mining industry generally.

The splendid arrangements and fine equipment that mark the important mines he controlled, will for many years be a monument to his ability and progressiveness. The "Safety First" movement, which he originated, and the rational sociological work among the mine workers, which he either originated or encouraged, will, however, be his greatest memorial. "Safety First" is destined to live as long as time shall last. When the coal fields which he aided in developing, and whose operations he directed, are worked out, abandoned, and forgotten, "Safety First" will continue, and its humane spirit will always be linked with the memory of Thomas Lynch.

Anthracite Mining

AFTER reading Mr. W. G. Whildin's description of mining thick pitching coal beds, our subscribers will no doubt agree with us, that the value of this article would be impaired somewhat had it been published in instalments and will excuse its unusual length This is the kind of paper that must be printed in full. From time to time inquirers ask us to inform them through our columns of the best method of mining thick steep pitching coal beds, and as we never knew and do not yet know, we are obliged to refer to the old general methods practiced in the anthracite fields. Therefore, Mr. Whildin's paper is a welcome addition to the literature on this subject, and it is to be hoped the continued efforts on the part of the Lehigh Coal and Navigation

Co. to find some economical and safe method whereby the excellent coal in the Mammoth bed pillars may be recovered will meet with success. Other anthracite companies have special systems probably, but so long as they are kept out of print the engineering fraternity will be unable to decide on their merits. We are not in accord with the president who told his manager that if he had an improved mining method he should keep it to himself, and not give it to others through the medium of a society or technical journal; for the reason that no system is perfect, and two heads are better than one when deciding on the merits of a mining system. Undoubtedly much anthracite can be saved by adopting new methods in recovering the pillars in steep pitching beds.

State Mine Inspector Upheld

"In the cutting of clay veins, spars, or faults, entries or other narrow workings, going into the solid coal, in mines wherein explosive gas is generated in dangerous quantities, a bore hole shall be kept not less than 3 feet in advance of the face of the work or 3 feet in advance of any shot hole drilled for a blast to be fired in."—*Rule 18, General Rules, Pennsylvania Bituminous Mine Law.*

In the court of Quarter Sessions of Fayette County, Pennsylvania, Judge J. Q. Van Swearingen, on December 1, 1914, handed down an opinion in the controversy of P. J. Walsh, State Mine Inspector, against E. L. Halbert, mine foreman of the Royal mine of the W. J. Rainey Co., for not maintaining bore holes as prescribed by the above rule. The defendant maintained that the bore holes are of no practical value in preventing mine explosions, and therefore the section of the mine law covering that point is null and void, because the enactment of such a law which fails of its purpose on account of its being of no practical value is not within the police power of the legislature to enact.

Judge Van Swearingen, however, delivered an opinion to the following effect:

"Under the evidence offered the practical value of the bore hole as an added element of safety to the miners is not certain. There is evidence to the effect that in some cases the presence of gas back of a clay vein will be denoted by the bore hole when otherwise it would not be discovered until released by a blast in a shot hole. There is other evidence tending to show that in most cases the presence of gas behind clay veins may be discovered in other ways almost as certainly as by the use of the bore hole, the evidence showing that in approaching clay veins the coal usually becomes, as the miners express it, 'curly,' that is, the cleavages of the coal become curled or twisted out of their natural bearings. There is evidence showing also that the coal near clay veins is not so bright in color as elsewhere, and sometimes is harder than at other places, and often is characterized by the presence of additional sulphur. These conditions, it was shown, usually will be regarded by experienced miners, although it was admitted by some of the witnesses that miners not observing closely may reach a clay vein without noticing the indications mentioned. The evidence shows also that the general use of safety or flameless powder in gaseous mines throughout the bituminous region greatly reduces the danger of explosions of gas in blasting down the coal. A summing up of all the evidence offered merely amounts to the statement that in many cases, in many localities in the bituminous coal regions, under conditions there existing, the use of the bore hole is not an added element of safety to the miners, while in other cases, in other localities, under the conditions that exist there, it is an added element of safety. Into which one of these classes a certain case may fall cannot always be foretold.

"The declared purpose of the Act of June 9, 1911, P. L. 756, as found in its title, is clearly within the police power of the state. That power, which extends to all regulations affecting the health, good order, morals, peace and safety of society, includes those which are reasonably necessary for the safety of employes in coal mines.

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"And now, December 1, 1914, it is adjudged that, while there may be an honest difference of opinion as to the benefits to be derived in all cases from a compliance with the provisions of Rule 18 of Article XXV of the Bituminous Mining Act of June 9, 1911, P. L. 756, as an added element of safety in the operation of the mines, the action of the legislature in adopting the rule was in the legitimate exercise of the police power of the state, being in a matter germane and properly related to the purposes of the Act, and that the rule, therefore, is valid, and is binding upon all persons coming within its provisions, and on the submission of this case to the court in the manner noted in the opinion herewith filed, on the question of the legality of the decision of the mine inspector of the Ninth Bituminous Mining District of Pennsylvania, in holding that the rule must be complied with as written, the decision of the mine inspector is sustained."

The law is placed on the statute books of the state for safer mining and should be obeyed until declared unconstitutional or repealed for any reason. There have been numerous occasions where loss of life has been the result of penetrating clay veins blindly and the liberated gas being ignited by open lights. Although in the case of the W. J. Rainey Co., such bore holes may have been useless, as the officials contended, the mine inspector being the officer of the state to whom the duty of enforcing mining laws is entrusted, has no alternative.

The Origin of Mine Gas

ON ANOTHER page in this issue will be found an article by Frank Haas, chief engineer of the Consolidation Coal Co., Fairmont, W. Va. While not knowing for sure, we believe that Mr. Haas wrote this paper for the purpose of inducing men to leave the groove they have been traveling in relative to mine gases. Undoubtedly he did not bring this subject up for discussion without having carefully considered it from every available angle, therefore his article is well worth reading and if possible digesting.

No doubt in the process of digesting some will choke; however, many will accept the hypothesis he advances (if such it may be called) and many will agree with him, at least on some of the points he makes. Those who will coincide with his views on the origin of mine gas will argue that all strata contain fissures, and that natural gas being under great pressure could work its way upward until it reached the coal, which is porous, and there find lodging. Those who will oppose this doctrine will declare that natural gas contains ethane and that this gas is not found in coal mines. Other opponents will state that a coal stratum, such as fireclay or shale, is impervious to water and is not fissured and consequently is not in the same class with jointed limestone and sandstone rocks. The arguments pro and con relative to the origin of methane or explosive mine gas, will draw out information possessed by few, and this will cause many to doubt whether their textbook knowledge is correct.

Another noted geologist while admitting that some marsh gas might have been formed during the carbonization of the vegetable matter of which coal is composed, cannot become reconciled to this being the sole source, claiming there is too much gas in some coal beds.

Mr. Haas' paper is not an abstruse argument to ventilate a preconceived theory on some phase of mine gas which in the end leads nowhere, but, on the contrary, he shakes loose ideas which have become almost fixed, and thus repaves old avenues for new vehicles of thought. This method of dealing with the subject usually makes the indifferent take notice and, therefore, discussions will follow which will teem with useful information to all.

Roof Falls in the Northern Anthracite Fields

IN COAL mining, an accident is an unfortunate occurrence incident to the regular course of things.

Every intelligent mine official will honestly deny the truth of the above statement, and the writer will agree with them in such denial. But, as we can predict, to within 1 or 2 per cent., the percentage of accidents that will occur from falls of roof and coal during the year, the statement is warranted by past experience.

In one attempt to analyze the cause for this condition, we were told by Mr. Edward W. Parker, of the United States Geological Survey, that all men, he presumed, were superstitious, but that we were the first to try to prove it by figures; therefore, to make the reasoning clear, we must revert to the early days of anthracite mining, and in this discussion refer to the northern anthracite district in Lackawanna and Luzerne counties, Pennsylvania. Previous to 1869 the miners commenced agitating for mine laws and for mine inspectors in order to lessen the number of lives lost per 1,000 men employed, claiming that the operators were not careful of their miners. After laws had been passed and inspectors appointed to see that they were enforced, the number of fatalities per 1,000 men employed did not decrease, so the miners blamed the inspectors. Evidently the mine inspectors became exasperated, for they claimed that at some mines the foremen were so ignorant they could not understand safety instructions or carry them out. Then a wise law was enacted, compelling all men who were to act as foremen or assistant foremen to pass an examination showing their competency to fill such positions.

After this law was passed and foremen were given certificates of competency, the percentage of fatalities due to falls of rock and coal did not decrease, so the miners and inspectors came to the conclusion that the inspectors could not properly cover their respective territories and examine conditions thoroughly at each mine. This appeared reasonable, and more inspectors were added. However, the percentage of fatal accidents due to falls of rock and coal, which is about 50 per cent. of all accidents in the northern anthracite district, remained about the same, and then the disasters were attributed to the inexperience of the men. Then under the guise of "police regulations" for the good of the industry and the preservation of life, the "Miners' Certificate Law" was enacted. Had this law been framed properly, it might have been instrumental in reducing accidents. As enacted, this law bars experienced English speaking miners from other fields from seeking work in anthracite mines, and fatalities from roof falls remain in the same proportion as before its enactment.

The operators have reversed the order originally followed, and instead of being blamed by the men are now blaming the men for carelessness. After spending thousands of dollars in safety measures without decreasing accidents, the operators, in some instances, have in a measure placed the safety of their men in the hands of safety committees composed of miners and mine workers, who act independently of the officials. As the majority of fatal accidents are due to falls of roof and coal, it seems to us that the proper way to reduce them in the northern anthracite field is to cut out part of the Miners' Certificate Law, use more timber, and use it as intelligently as do the experienced miners in the bituminous fields. Injuries and deaths from roof falls have been decreased in the bituminous coal fields of Pennsylvania, where there is no certificate law and where more systematic timbering is followed. In 1912 in the northern anthracite field 94,920 men were employed, of which number 153 met death from roof falls. Going a step further, we find that 119, or 77 per cent. of the killed were foreign speaking. In the bituminous fields of Pennsylvania 365,295 mine workers found employment and 249 met death from rock and coal falling on them, which is equivalent to .682 death per 1,000 men employed. The number of persons killed by falls in the three anthracite fields in 1912 was 246, but 62.19 per cent. of these happened in the northern field, or 1.61 deaths for every 1,000 men employed. As an evidence that the number of these deaths may be reduced one-half, the record of the H. C. Frick Coke Co. is taken before and after they adopted systematic timbering. In 1909 this company mined 311,445 tons of coal for each life lost, in 1912 this same company mined 563,530 tons of coal for each life lost. As more conclusive evidence of the value of scientific timbering, statistics from the Department of Mines show that in the bituminous fields of Pennsylvania 590 men were killed by falls of rock and coal in 1909, and in 1912 only 249 men were killed by similar accidents. In coal mining an accident is an unfortunate occurrence in most instances preventible.

Finely pulverized coal begins oxidation at a temperature of about 120 or 130 degrees. The ignition temperature varies with the kind of coal. Finely divided bituminous coal ignites in oxygen at a temperature not far from 150 degrees; buckwheat size at from 260 to 300 degrees; semibituminous coal is said to ignite at about 200, and anthracite, if finely divided, at about 300.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.
The editors are not responsible for views expressed by correspondents.

Welfare Work in New Mexico

Editor The Colliery Engineer:

SIR:—On Friday evening, October 23, in the Rescue Station Hall, Dawson, the mine officials of the Stag Cañon Fuel Co. were entertained at a banquet given by the company. Almost all the officials were there, including the fire bosses, and as it was rather an informal affair every one seemed to enjoy themselves. After supper General Manager Tom H. O'Brien, who presided, gave an address on "Safety First" and as this was the object of the meeting, the rules which had been drawn up for the various officials were read, and an animated discussion followed. Committees were also appointed from the officials who work on the surface, and from the pit bosses, and fire bosses, to inquire into and report on what further safety measures could be adopted in their various spheres.

It is worthy of note in this connection, that the company won the confidence of the public both during the time of the explosion last year, and in the "safety first" improvements they have installed since.

During the first week of the explosion, the volunteers who entered the mine were supplied with all the food, fruit, and soft drinks they wanted, and in some cases they got overalls and shoes, but as some strangers who came made too good use of this condition of things, it had to be stopped, it was said of some of these men that they came for the free lunch and not to work.

Some of the widows got $1,500 and an allowance made for each child and all other expenses were paid. This compares favorably with what any other company has done in similar circumstances.

Since that time, boilers have been erected to supply steam and heat to the air as it enters the mine; in some cases the pipes which carry the steam are placed in rows above each other at the entrance to the mine. These rows are about 5 feet high and 20 feet long; from these a single line of pipe is led for some distance into the mine and the steam allowed to blow off from perforations in the pipe; this gives both heat and moisture to the air as it enters, so that as long as it remains saturated with moisture it cannot extract moisture from the coal dust as it travels through the mine, since heating the air as it enters to the same temperature as the interior of the mine prevents it from being expanded by the heat from the strata, and therefore it cannot hold any more moisture. Sprinkling the dust by hose from a line of water pipes which is carried through the main roads is kept up as formerly.

A great deal of reliance is being placed on the fact, that inert dust is being scattered along the main roads, some of the motor roads are imbedded in it. These, with other improvements, such as the erection of large new fans, have made it a busy year in Dawson along the "safety first" lines. The need of discipline among the men was emphasized at the meeting and some attention will be given to this.

Another movement has been revived in Dawson quite recently, although it was not mentioned at the meeting. The company has supplied all the mines with a full equipment of "first-aid" appliances for practice with the result that "first-aid" work is getting considerable attention. The company intends sending a team to the Panama Exposition next year and will bear all expenses. It is needless to point out the good effect this has upon the public mind when reference is made to the Stag Cañon Fuel Co. and goes a long way to promote harmony between employer and employe.

ROBERT MCCUNE

Dawson, N. Mex.

West Virginia Mining Institute

The annual meeting of the West Virginia Mining Institute was held at Huntington, December 10 and 11. There were a large number of operators, mining engineers, and mining men present, although the members of the Smokeless Coal Operators' Association could not be present owing to their having an important meeting in Philadelphia, where they gave John J. Tierney, their president, a Tiffany pocket chronometer. President Neil Robinson was unable to be present and in his absence Mr. J. C. McKinley presided. After listening to the secretary's report, Mr. E. B. Wilson was requested to read Miss Marguerite Walker Jordan's paper entitled "The Practical Way to Increase a Miner's Efficiency." This paper was heartily applauded. The next paper was by Richard Smethurst, of Cincinnati, on "Cost Accounting." This valuable paper dealt with a subject which must be more and more understood as mining progresses. It is not enough to know whether there is a debit or credit balance in the bank, and if details are not followed the chances are that there will come a day when there will be a debit balance.

Mr. Smethurst gave a clear description of the methods he would advise for cost accounting and the benefits, not only in saving, but in making an efficient force of employes.

Hon. Z. T. Vinson, a corporation lawyer of Huntington, W. Va., ad-

vised coal men to fight adverse legislation and the mine workers' union. He advocated the formation of an enormous defense fund to fight enemies of the coal industry in this and other states, and to obtain this fund by means of an assessment of 1 cent per ton of each mine's output. This based on 68,000,000 tons yearly production would be some fund. Colonel Vinson stated that the operators' remedy for present conditions was to fight. There had been too much compromising and temporizing with the politician, the trust buster, and the agitator, under the delusive hope that they would ultimately leave the coal mine operator in peace. The operators could make such a fight by organization that will represent the combined powers and influence of all the operators in the state. With such a combination any political party in the state could be overthrown, and the avowed purpose of the United Mine Workers to confiscate your property as well.

The speech was rather radical for the usually sedate deliberations of the West Virginia Mining Institute.

The next paper on the program was "Mine Gases," by Mr. Frank Haas, of Fairmont. This paper was intended to drift away from the earlier notions regarding mine gases and come to the cold facts of what are known of mine gases at the present time. He was inclined to the belief that methane in mines came from deep down below the mines and not from the coal.

Ray V. Hennen, geologist, Morgantown, W. Va., next described the Pottsville measures west of the Kanawha and New Rivers. Mr. Hennen made use of a chart and was asked a number of questions relative to his sections which he answered satisfactorily.

The election of officers was preceded by a movement to amend the constitution in order to establish associate memberships. The associate memberships would be held by mine owners and big corporations, who could afford, it was said, to pay relatively heavy assessments to further the interests of the Institute. Regular members pay $2 per year dues, and this is insufficient to meet obligations and do the printing, especially when many fail to pay promptly. The transactions of the Institute would be of great benefit to the corporations and owners, if enough money can be raised to place them where they will do the most good. It is expected that the Institute will publish a monthly bulletin within the next few months. After the amendments were referred to a committee, the election of officers for the ensuing year was taken up.

Mr. J. C. McKinley, of Wheeling, was elected president. In the election of vice-presidents the state was divided into districts and a vice-president chosen to represent that district.

Col. William Leckie, of Welch, was elected vice-president of the Pocahontas district.

Earl C. Henry, of Charleston, was made vice-president and representative of the Kanawha district.

E. E. White, of Glen White, was elected vice-president in the New River district.

George T. Watson, of Fairmont, was made vice-president to represent the northern district, while the upper Potomac district is represented by J. W. Bischoff, of Elkins, W. Va.

This distribution of executives it is believed will be instrumental in increasing the number of members and adding to the Institute's prestige.

Prof. E. W. Zern was reelected secretary-treasurer with headquarters at the State University, Morgantown.

Miss Mary K. Quick, Moundsville, W. Va., read a paper on "The Visiting Nurse," which appealed to all present. Some one proposed that she be made an honorary member because of her paper; this, however, was negatively decided, as the members thought the matter would be a precedent that could not be lightly ignored. Individually the writer believes it would be a good feature to have women members, particularly since it is proposed to change the constitution permitting all interested in mining to join.

Dr. Peter Roberts, of New York City, gave his very interesting lecture on "Teaching English to the Foreigner." Dr. I. C. White, State Geologist, spoke of the work being carried on in the mining districts by the University Extension School. He believed that the solution of the problem of efficiency and contentment depends largely on educating the people interested in the coal mining industry.

The entire morning of the second day's session was devoted to the question box, and it ran over into the afternoon. The subjects discussed were practical and there were few in attendance who were not moved to voice their ideas. Professor Zern is the one responsible for the questions.

The other papers presented were "The Benefit of Good Roads to a Mining Community," by Hon. A. D. Williams, Morgantown, W. Va. "Storage Battery Locomotives," by G. H. Shapter, Charleston, W. Va. "Roof Supports," by Fred C. Keighley, Uniontown, Pa.

Huntington is the most remarkable city in West Virginia. Its office, bank buildings, and other public buildings are modern in construction and appointments. It is the youngest city in the state and the second largest, being credited with a population of 36,000. The citizens are proud of their city and make it a point to see that visitors are induced by entertainment to speak well of it. Mr. Dez C. Schoenthal, who induced the Institute members to adopt the city for two or three days, is hereby acknowledged to be a host by himself, for he left the West Virginia Rail Co. for a longer period than 3 days in order to supervise the plan and erection of the most bountiful entertainment ever provided the Institute. The "Battle of Huntington," which took place 5 years ago is now commemorated by a marble shaft of gratitude erected by the members of the West Virginia Mining Institute and presented to the

people of Huntington as a whole, and particularly to the Jobbers and Manufacturers' Association. The banquet, while without wine, was a most enjoyable affair, aside from the food which, as the *Huntington Dispatch* stated, was the most elaborate ever served in West Virginia.

A Bit of Pump History

Written for The Colliery Engineer

One of the first, if not the first man to build a practical and efficient double acting simplex pump was the late Andrew Scott Cameron, founder of the A. S. Cameron Steam Pump Works.

Some 50 years ago Mr. Cameron, a young Scotch machinist of New York City, designed the first direct acting piston pump with an enclosed steam-thrown valve, and the present types follow closely the general lines of this original Cameron pump. After many struggles and personal privations he succeeded in establishing a model shop on the east side of New York City, and from this small beginning the large business of the A. S. Cameron Pump Works has developed.

The first simplex pump designed by Mr. Cameron was true to its name—simple in construction and simple in operation. Into this pump were built characteristics of strength and durability. Another noteworthy feature was the absence of any outside valve gear or unprotected moving parts.

Naturally, the introduction of new machinery in the days of half a century ago, no matter how meritorious, was comparatively slow work; but the Cameron pump filled a requirement that made its introduction very rapid. As a result expansion was made in the shop, and finally the large plant at the foot of East Twenty-third Street was secured to take care of the increased business.

From time to time Mr. Cameron made detail improvements in the pump to meet changing conditions without, however, affecting the basic principles of his original design.

When the demand was created for efficient station and sinking plunger pumps, the Cameron engineers designed a horizontal and a vertical plunger pump on the same principles as the original horizontal piston pump. These Cameron plunger pumps enjoy an equally high reputation with the piston pump, and they have proved especially serviceable in pumping gritty mine water. Before his death, Mr. Cameron had the satisfaction of knowing that Cameron pumps were in use in every coal field in America for all services from boiler feeding to mine drainage.

That he was not alone in his opinion that a simplex pump of a few working parts and durable construction possessed superior merits, is proved by the steady growth of the Cameron pump business, until it became so extensive that it was necessary to build a new modern plant of largely increased capacity. This plant, located at Phillipsburg, N. J., is 100 feet wide by 600 feet long with a number of auxiliary buildings.

With progressiveness as its watchword, the Cameron management have added to the line of simplex pumps a complete line of centrifugal pumps, including single-stage, single-suction, and double-suction, and multi-stage turbine pumps. There are many of these Cameron centrifugal pumps now installed in mine drainage work, giving efficient and economical service.

That coal mine officials, the men who solve the various water problems at the mines, the men who want the most efficient and economical equipment, also appreciate the qualities of Cameron pumps is evidenced by the number of such pumps in daily use. Space will not permit giving a complete list of these users, but it is of interest to note a few of the companies that each use a considerable number of them. Among these are the Buffalo & Susquehanna Coal and Coke Co., that uses 77 Cameron pumps for various purposes in the Jefferson, Pa., field; the Keystone Coal and Coke Co., that uses 52 in the Greensburg, Pa., field; the Morrisdale Coal Co., at Morrisdale, Pa., that uses 27; the Lehigh Coal and Navigation Co., in the anthracite fields, that uses 41; the Rochester & Pittsburg Coal and Iron Co., Punxsutawney, Pa., that uses 35, ten of which at Luzerne are large pumps with special water ends; the Clinchfield Coal Corporation of West Virginia, that uses 17; and the New River Coal Co., Eccles, W. Va., that uses nine Cameron pumps, five of which are of large size.

The Steel Corporation at Panama-Pacific Exposition

The Palace of Mines and Metallurgy at the Panama-Pacific International Exposition will house a vast display of minerals and show the various methods of extraction and manufacture.

The structure devoted to the mineral interests is 451 ft. × 579 ft. in size and has a floor area of 252,000 square feet. The total cost of erection has been $359,445. By the time that the Exposition opens on February 20, every exhibit will be in its place. The war has not affected the extent of the mineral exhibits in any way.

The exhibit of the United States Steel Corporation and its subsidiary companies, the largest single exhibit in the Exposition, is already practically installed. The exhibit will prove a surprise as it portrays comprehensively the numerous activities of the greatest mining and manufacturing corporation in the world.

The exhibit will show by models, samples of the products and by pictures and maps, methods of coal mining and making of coke, and details in mining iron ore and its manufacture into iron and steel products.

The companies included in the coal and coke making section are the H. C. Frick Coke Co., operating in Westmoreland, Fayette, Greene, and Washington counties, Pa., 61 coke plants consisting of 19,806 beehive coke ovens and seven coal

plants not engaged in the manufacture of coke; the United States Coal and Coke Co., with properties in McDowell and Wyoming counties, W. Va., and Tazewell County, Va., and operating 12 coal plants, seven of them having a total of 2,151 beehive coke ovens; the Bunsen Coal Co., operating six coal plants in the Indiana and Illinois fields; the National Mining Co., operating two coal plants in Allegheny County, Pa.; and the Sharon Coal and Limestone Co. with five plants in Lawrence and Mercer counties, Pa.

The coal exhibits in the section are a large channel section, practically the full width of the Pittsburg, or Connellsville, seam of coal in Pennsylvania, operated by the Frick company; a cube of coal furnished by the National Mining Co., from the Pittsburg seam in Allegheny County; two cubes from the Bunsen company, one being from No. 4 seam, Clinton district, Vermilion County, Ind., and the other from the No. 6 seam, or Grape Creek coal seam, in the Westville district, Vermilion County, Ill.; the United States Co. displays a cube from the No. 3 Pocahontas seam and one from the No. 4 Pocahontas seam, both from McDowell County, W. Va. There is also an exhibit of the famous Connellsville coke; and the work done in the safety and welfare department will also prove of interest.

A modern coal and coke plant having a capacity of 1,200 to 1,300 tons of coke per day is shown in a 1/16 full size model. The headframe and coal bin are of steel construction and the foundations of concrete. The shaft leading from the adit to the seam below is concrete lined. The hoisting engine house, boiler house, oil and supply houses, repair shop, lamp house, emergency hospital, miner's change house, and the fan houses, are constructed in a substantial manner and have roofs of galvanized, corrugated steel. The boiler stack and the ring walls of the ovens are of concrete construction. At the rear of some of the ovens are flues which conduct the hot gases from the ovens to boiler plants where steam is generated by means of the heat from the gases. A typical miner's bath and change house is shown, equipped with shower baths and arrangements for drying the work clothes.

The coking of coal is illustrated in a working model of a beehive coke oven and by a model of a Koppers by-product coke oven. The models are designed to be mechanically operated. The by-product exhibit of the coke-oven operation is of particular interest. The relative proportions of the various products such as coke, fuel gas, etc., extracted from a cubic foot of coal are displayed; and the charts and photographs illustrating the processes and giving statistics are well worth seeing, as is also an electrically driven coke extracting and loading machine that is shown in operation.

All haulage tracks above and below ground are of steel including the cross-ties. All mine cars and wheels and all poles carrying electric transmission lines and trolley lines, are of steel. In the underground workings, the landings at the shaft bottom, pump machinery rooms, haulage engine rooms, mine stables, mine offices, "first-aid" rooms and air bridges, or overcasts, are constructed either of steel or concrete or both. The steel mine props, steel mine timbers, and steel ventilating pipe for use in the advance workings are shown.

All models are correct in every detail, and also show the close attention given to sanitary and tidy surroundings and the cultivation of flower and grass plots wherever possible.

Various safety devices intended to keep workmen informed of danger points, are displayed. There are "danger" signs in conspicuous places. The ladders on the boiler stack and tank are guarded by a safety cage. There is a device at the surface landing of the shaft which prevents the opening of the gates until the cage is in the proper position at this landing which acts as a fulcrum releasing the locking device. The device acts as a safety switch when the gates are open which at all other times prevents mine cars from entering the shaft. There is also an illuminated "Safety First" sign.

In the fireproof moving picture theater operated as a part of the exhibit the displays in this section are enhanced by the use of moving pictures which show the various processes.

BOOK REVIEW

A review of the latest books on Mining and related subjects

The Anthracite Combination, by Dr. Eliot Jones, Ph. D. This is Vol. XI of the Harvard Economic Studies. It is 8 vo., cloth, 275 pages. It is illustrated, with charts and maps. Price $1.50. Howard University Press, Cambridge, Mass. The book forms a study of the growth of the coal industry and consolidation of the coal interests under the control of a number of railroads. The detailed treatment of the history, and analysis of the effects of combination upon the production and price of coal furnish more than an ordinary trust-problem discussion: they involve questions of the preservation of national resources, the limitations on carriers, and the rights of consumers. Statistics, significant letters, maps, and Supreme Court decisions are appealed to in marshaling the facts in one of the most interesting histories in this country.

De Laval Catalog "B." What is probably the most complete commercial publication devoted solely to centrifugal pumps is being distributed by the De Laval Steam Turbine Co., of Trenton, N. J. This book of 298 pages contains over 300 illustrations. The text is divided into chapters and indexed. It is really a valuable textbook of information.

PERSONALS

The Sunday Creek Coal Co., of Columbus, Ohio, has been reorganized and Mr. J. S. Jones elected president. J. H. Winder, formerly president of the company, returns as general manager, succeeding N. D. Monsarrat, the former manager of the mines. P. A. Coen, of the Rail and River Coal Co., has been appointed general sales agent.

S. C. Gailey, formerly vice-president and auditor of the Sunday Creek Coal Co., has resigned to become assistant to the president of the Pittsburg Coal Co. at Pittsburg, Pa.

Mayor E. B. Jermyn, of Scranton, Pa., has appointed Arthur W. Long, of Dunmore, Pa., as Chief Engineer of the newly created Mine Cave Bureau recently authorized by the city of Scranton to deal with the questions relating to the effect of mine workings on the surface in some parts of the city.

Martin Bolt, chief clerk of the State Mining Board of Illinois, has resigned that position. Governor Dunne has appointed James F. Morris to fill the position.

The Pennsylvania Coal Co., of Scranton, Pa., announces the following changes among its officials: Edgar A. Weichel, of Pittston, Pa., for a number of years general inside foreman of the Butler colliery, is transferred to be general inside foreman of the Underwood colliery at Throop. George V. O'Hara, of Pittston, Pa., inside foreman at the Barnum colliery, transferred to Butler colliery, to succeed General Foreman Weichel. James Johnson, inside foreman at Fernwood colliery, transferred to the Barnum, as the successor of Mr. O'Hara. Ludwig Weichel, heretofore employed as a yardage checker, appointed inside foreman of the Fernwood to succeed Mr. Johnson.

The Holliday Coal Co., of Nuttalburg, W. Va., has appointed William Farrell as general manager. Mr. Farrell was formerly connected with the New River company at Glen Jean, W. Va.

H. D. Mason, Jr., is now stationed in Pittsburg, Pa., as assistant to J. W. Paul, Chief of the Rescue Division, United States Bureau of Mines.

M. D. Royer, of the Lehigh Valley Coal Sales Co., has resigned his position to become traffic manager for the Manila Railroad Co., at Manila, P. I.

Delwyn Wolf, division engineer of the Lehigh Valley Coal Co., has been promoted to district inside superintendent with headquarters at Hazleton, succeeding Thomas R. Jones, who now has charge of the Mahanoy Division of the same company.

W. B. Williams, general superintendent for the Utah Fuel Co., has severed his connection with that company. He has been so closely associated with coal mining in the West and has so wide a circle of friends, that a few remarks concerning his record will be timely. Mr. Williams was born at Carbondale, Pa., in the anthracite regions, his father, Thomas B. Williams, being one of the pioneer mining engineers of the anthracite fields in the fifties; thus his earliest days were spent amid an atmosphere of mining. "W. B.," as he is familiarly termed by all of his acquaintances from trapper to president, started his mining career with the old Pittston & Elmira Coal Co., Pittston, Pa., serving consecutively with the Lackawanna Coal and Iron Co., and the Hillside Coal and Iron Co., in all of which he occupied humble positions which served as stepping-stones to higher positions until at the close of his service with the Hillside Coal and Iron Co. he was general inspector. Leaving Pennsylvania, he took charge of the Missouri coal operations of the Missouri Pacific Railway Co., and subsequently those in Arkansas. These positions were filled with much merit to himself and benefit to his company. In July, 1906, Mr. Williams became general superintendent for the Utah Fuel Co., which position he held until his resignation. Mr. Williams was vice-president for Utah of the Rocky Mountain Coal Mining Institute. Those who had the pleasure of visiting the session at Salt Lake City in 1913 will remember the regal good time provided, which was greatly due to his efforts.

As a compliment to retiring President William McKell, and retiring Secretary W. R. J. Zimmerman, the New River Coal Association served an elaborate banquet at the Dunglen Hotel, at Thurmond, on the evening of January 5, when a handsome and beautifully engraved gold watch was presented to each of the retiring officers. The newly elected officers of the Association are Col. C. C. Beury, president; William McKell, vice-president; N. S. Blake, secretary and treasurer.

D. J. Parker, mining engineer, is in charge of Car No. 8, United States Bureau of Mines, now in McDowell County, W. Va.

W. H. Clingerman has been made president of the H. C. Frick Coke Co. in place of Thomas Lynch, deceased.

R. H. Buchanan, former assistant manager Madeira-Hill Co., has been made general superintendent of the Oak Hill Coal Co., Duncott, Pa.

Foremen's Experience

By a decision handed down by the Dauphin County Court, at Harrisburg, Pa., on January 6, the application of President James Matthews, of the United Mine Workers of America, to restrain the various mine examining boards in the anthracite regions from granting foremen's or assistant foremen's certificates to those who have not had 5 years' experience as a miner and yet have been successful applicants at the Board's examination, was dismissed. The Court decided that all candidates who had worked inside the mines for at least 5 years and had attained the required percentage in the examinations submitted by the examining boards should be granted their certificates.

Why Optimism?*

Europe's war finds its echo in America's industry. What contrast could be greater; on the one shore of the Atlantic all activity seemingly destructive in purpose; on the other shore, every energy directed along constructive lines; absolute waste of life and property as opposed to production of wealth and betterment of life.

Even though it is at a distance that we view the terrible disaster that threatens the whole continent of Europe, optimism seems a lost art. Yet sooner or later this epoch of catastrophe must be followed by a period of repair, and the longer this period is delayed the greater will be the needs involved in the reconstruction and replacement. Where war has torn down at terrific speed, peace must build up slowly.

The interruption of international trade stopped our exports of cotton and copper and our imports of dye stuffs and potash, whereby several important industries were well nigh paralyzed. Yet startling as has been this disturbance of the whole balance of industry, certain fundamental facts and laws remain for us to build upon, and indeed the lower course of foundation stones for optimism has already been laid.

Evidence of business betterment and the reasons for optimism are many. The United States farmer has harvested a five billion dollar crop and there is a high-price market for all our surplus food stuffs; already our grain is crossing the Atlantic. The millions of men who are fighting and not working must be clothed and equipped as well as fed. Foreign orders have started factory operation which at once tends to relieve the stagnation in the steam-coal trade, the steel situation has turned from serious depression to rapid improvement and the whole mineral industry may soon expect to share in this general business improvement.

*Extracts from address by Geo. Otis Smith, Director, United States Geological Survey, at the American Mining Congress, December 8, Phoenix, Ariz.

Today the financial horizon is so nearly cloudless that the prophets of bad weather have little upon which to base their predictions. The new federal banking system makes the money reserves mobile as never before, and extension of credit is now possible, without the veto power remaining in the hands of a small group of big men. Still another reason for belief in business betterment is the recognition, now becoming widespread, of the general interdependence of big business and the general public. On the one side, the people are realizing that they are and have been in reality the silent partner in big business and now that there has come the promise of some regulation that will in large part prevent monopolistic centralization, the people are interested in getting their share of returns that can come only with operation at a profit. On the other hand, the managers of the large corporations, the trustees of the investing public, are beginning to see that a certain financial security goes with public confidence, and that the attitude to the public so tersely expressed 30 years ago by a pioneer in railroad financing does not pay dividends today.

Of course optimism is apt to go to extremes and a period of overstimulation may threaten us, a condition that is somewhat symptomatic of the American temperament. The 4 months' record, however, can be summarized thus: While European countries have been mobilizing their armies and calling to the field of battle their reserves of soldiers, America has mobilized its credit and begun to send forward to the market place its vast reserves of food stuffs and mineral products.

Secretary Redfield recognizes three periods of business condition as naturally following the declaration of war on August 1 last—those of shock, stimulation, and readjustment. These three must be expected to affect in the same order all branches of American business, though the transition from one period to the next may not be simultaneous in all branches. Thus for several weeks after war was declared, the exportation of wheat felt the shock and thousands of carloads accumulated at Eastern ports. With cotton the period of shock has been longer, but stimulation of export has now begun. With copper the resumption of sales to Europe seems slow in coming, but come it must, for in the modern world it is a necessary of life.

Our commerce with South America for the last four years has been one-sided to the extent of an unfavorable annual trade balance averaging more than 80 millions of dollars. The fact that the balance of trade is against the United States in two of the three "A B C" countries should be taken as an invitation to export more, and that 80 millions suggests the chance for further development of trade relations.

To increase industrial prosperity, this country needs to export finished rather than crude products and to import raw materials rather than manufactures. Betterment of industrial conditions can come best through expansion of manufacturing. The increase of the element of labor in the product exported will mean that we are not bartering away our heritage of natural resources, but rather that we are using these resources as a basis simply for the expenditure of labor, which renews itself.

Coming down to bottom facts, the United States will profit by the European war only as the nation makes larger and wiser use of its mineral resources. Foreign markets in the main can be won and held only as the quantity or quality of the "Made in America" product rivals that of the goods offered by the other producing nations. The buyer, whether he be in the Far East or in South America, wants the most and the best for his money. Yet it would seem a safe rule of national conduct that industry should begin at home, and therefore every industrial opportunity in America should be improved. If these opportunities are recognized and grasped every one of us can indulge in optimism.

ANSWERS TO EXAMINATION QUESTIONS

Questions Selected From Those Asked at Examinations for Mine Foreman and Fire Boss in Various States in 1914

QUES. 1.—How can you learn by comparing your steam gauge and safety valve with each other, whether they are correct?

ANS.—Shift the safety-valve weight from place to place on the lever and raise the steam pressure by firing up the boiler until the valve blows off. Calculate the pressure required to cause the valve to blow off at each position of the weight and compare this with the reading of the steam gauge taken at the same time. If the calculated pressure and that recorded by the steam gauge agree within a few pounds, both valve and gauge may be taken to be working properly. If they do not agree, the steam gauge should be compared with one known to be correct, when another comparison with the safety valve should be made.

QUES. 2.—What quantity of air is passing through an airway 6.5 feet wide at the top and 9.5 feet wide at the bottom and 6 feet high, with the anemometer reading 200 revolutions per minute?

ANS.—The average width of the airway is $(6.5+9.5)\div 2=8$ feet. The area of the cross-section of the airway is, thence, $8\times 6=48$ square feet. If it is assumed that the anemometer is in perfect order, then 200 revolutions are equivalent to a velocity of 200 feet a minute, and the quantity of air passing will be $48\times 200=9{,}600$ cubic feet per minute. An anemometer is a delicate instrument and liable to be out of order so that it records less than the true velocity; hence, the quantity of air actually passing may be some more than that calculated.

QUES. 3.—What precautions should you take to avoid accidents on a gangway along which men are obliged to travel and upon which cars and mules or cars and motors, are passing frequently?

ANS.—The track should be laid along one rib so that there may be a continuous path of ample width along the other side of the gangway. This path should be kept clean, and free from obstructions. At intervals of from 50 to 100 feet refuge holes should be cut in the rib to a depth of from 3 to 4 feet. These holes should be from 6 to 10 feet wide and should be whitewashed so that their position is perfectly clear. The mouths of old rooms or chambers will answer the purpose if kept clear of obstructions such as the ends of chutes, piles of gob, etc.

The Pennsylvania Anthracite Mine Law says that where passageways are also used for transportation the safety holes must not be more than 150 feet apart. On haulageways where cars are spragged, at least 2 feet of space must exist between the side of the car and the rib.

In addition, if electricity is the motive power, the trolley wire should be hung on the narrow side of the gangway, that is, on the side opposite the footpath and refuge holes, and should be carried in an inverted wooden trough the sides of which are 3 or 4 inches deep.

QUES. 4.—In what time can an engine of 40-horsepower pump 4,000 cubic feet of water from a shaft 360 feet deep?

ANS.—As the weight of a cubic foot of water may be taken at 62.5 pounds, 4,000 cubic feet will weigh $62.5\times 4{,}000=250{,}000$ pounds. As this weight of water must be raised 360 feet, the number of foot-pounds of work, that is, the number of pounds raised 1 foot high, will be $250{,}000\times 360=90{,}000{,}000$. Since 1 horsepower is equal to 33,000 pounds raised 1 foot in 1 minute, 40-horsepower will raise a weight of $40\times 33{,}000=1{,}320{,}000$ pounds 1 foot high in 1 minute. To raise 90,000,000 pounds 1 foot high, that is, to do 90,000,000 foot-pounds of work, will take a 40-horsepower engine, $90{,}000{,}000\div 1{,}320{,}000=68+$ minutes, or, say, 1 hour and 10 minutes.

QUES. 5.—To what do you attribute the cause of the greatest percentage of accidents in our anthracite mines?

ANS.—The greatest number of accidents in the anthracite, as in the bituminous, mines is caused by disobedience of orders by, and carelessness and ignorance upon the part of, the victims themselves or of their fellow workmen. The question may, perhaps, be answered in another way and from another view point, by saying that the greatest number of accidents is due to falls of roof.

QUES. 6.—How many cubic yards of rock are there in a shaft that is to be sunk having a depth of 900 feet, 12 feet wide and 20 feet long?

ANS.—The number of cubic feet of rock to be taken out is first found by multiplying the three dimensions together, and is $900\times 12\times 20=216{,}000$ cubic feet. Since there are 27 cubic feet in 1 cubic yard, the sinking of the shaft will require the removal of $216{,}000\div 27=8{,}000$ cubic yards of rock.

Ques. 7.—When old workings are walled off air-tight, what changes are likely in the composition of the atmosphere?

Ans.—The proportion of oxygen in the air in the sealed off workings will be reduced, either by an increase in the amount of other gases given off by the coal or the surrounding rock as methane and carbon dioxide, or by the replacement of the oxygen by carbon dioxide due to the combination of atmospheric oxygen with the carbon of the coal. Naturally, the amount of change will depend upon the length of time the workings are sealed, and, after several years it is possible that all the oxygen will be consumed so that the remaining atmosphere is in no way different from an afterdamp. If the absorption of oxygen by the coal is sufficiently rapid to produce combustion, a greater or less amount of carbon monoxide will be produced.

On the other hand, if the workings are near the crop and free from methane, if the surrounding rocks do not give off gas and if the coal is hard and dense, like anthracite, and so not liable to spontaneous combustion through the absorption of oxygen, it may be a long time before the atmosphere of the sealed-off workings is either unfit for breathing or becomes explosive.

Ques. 8.—An entry is driven 1 mile due south from the hoisting shaft; another is driven 1 mile due east from the head of this entry. You want to connect the head of the cross-entry with the main-entry at a point distant 280 feet from the shaft bottom. Find the length of this diagonal.

Ans.—The main and cross-entry intersect at an angle of 90 degrees and form two sides of a right-angled triangle. One of these sides, the cross-entry, is 1 mile, or 5,280 feet long; the other side, the main entry, is 280 feet less than 1 mile in length, and is $5,280 - 280 = 5,000$ feet long. The required diagonal is the hypotenuse of a right-angled triangle whose sides are 5,280 and 5,000 feet, respectively. Hence,

Diagonal $= \sqrt{5,280^2 + 5,000^2} = 7,272$ feet, about.

Ques. 9.—Name principal essentials for an explosive to be used in coal mines.

Ans.—The powder best suited for use in coal mines is (*a*) safe, that is, its explosion produces such a small amount of flame that it cannot ignite either methane or coal dust; (*b*) is slow acting, that is, its force is exerted over a considerable space of time compared with, say, dynamite, which is instantaneous in action, in order that the coal may not be shattered and may be produced with the largest amount of lump; (*c*) it must be reasonable in price. These conditions are met by the permissible powders, tested and approved by the Bureau of Mines.

Ques. 10.—Find the difference in capacity of a 2-inch and a 3-inch pipe.

Ans.—If by capacity is meant the volume of a given length of pipe, the volumes or contents of the pipes will be in the ratio of the squares of their respective diameters. Thus, a 3-inch pipe of any length will hold $3^2 \div 2^2 = 9 \div 4 = 2.25$ times as much water or other liquid as the same length of 2-inch pipe.

If by capacity is meant the quantity of water discharged by the two pipes in the same length of time and with the same head, the difference in capacity will be in the ratio of the square roots of the fifth powers of the respective diameters. Thus, a 3-inch pipe as compared with a 2-inch pipe will discharge $\sqrt{3^5} \div \sqrt{2^5} = \sqrt{243} \div \sqrt{32} = 15.59 \div 5.66 = 2.75$, or $2\frac{3}{4}$ times as much water as a 2-inch pipe when the head is the same.

Ques. 11.—(*a*) What causes spontaneous combustion of coal? (*b*) What would be the first indication of it in an old room where a pile of loose coal had accumulated?

Ans.—Spontaneous combustion is caused by the combination, without artificial aid, of the oxygen of the air with the carbon of the coal to form carbon dioxide, and is, in reality, a slow burning of the coal. When this action is sufficiently rapid, enough heat will be generated not only to drive off the gases contained in the pores of the coal, but also to ignite these gases and any carbon monoxide that may be produced through the incomplete combustion of the carbon. The presence of iron pyrites, sulphide of iron, does not make a coal more liable to spontaneous combustion.

(*b*) The first indication of spontaneous combustion may be in the form of steam or vapor caused by the heating of the water and included moisture in the coal, but this is accompanied with and often preceded by the peculiar odor due to the various hydrocarbon compounds and woody acids distilled from the coal at a low temperature.

Ques. 12.—You have a piece of coal land in an exact square and containing 1,296 acres. How long will be the line connecting two opposite corners of this tract?

Ans.—The length of the diagonal will be equal to the square root of twice the area, expressed in square feet, of the land in question. Twice the area is $2 \times 1,296 \times 43,560 = 112,907,520$ square feet. The length of the diagonal is the square root of this double area and is 10,625.8 feet, about.

The problem may be solved with fewer figures by extracting the square root of twice the area, expressed in acres, and multiplying this result by the length of the side of a square figure containing 1 acre, that is by 208.71 feet. Thus, $\sqrt{2 \times 1,296} = 50.91$, and $50.91 \times 208.71 = 10,625.8$ feet, as before.

Ques. 13.—(*a*) What is the theoretical limit of a lifting pump at sea level? (*b*) What is the principle involved? (*c*) What is meant by suction?

Ans.—(*a*) The theoretical height to which a pump will draw water is, at sea level, about 34 feet.

(*b*) By the forward stroke of the plunger of the pump a vacuum is made in the cylinder behind it. The pressure of the air forces the water in the sump upwards through the suction pipe into the cylinder. At the beginning of the return stroke the valve connecting the water

cylinder and the suction pipe is closed, and the water is forced to the surface by the plunger. The pressure of the atmosphere is equal to 14.7 pounds (about) upon each square inch of surface of the water in the sump. A column of water 1 foot high and having a cross-section of 1 square inch, weighs .434 pound. When the weight of the column of water is equal to that of the air of the same cross-section (1 square inch), the water will rise no higher in the suction pipe. A column of water $14.7 \div .434 = 34$ feet, about, will produce the same pressure per unit of surface as a column of air of the height of the atmosphere; hence, this is the theoretical height to which a pump will suck or draw water.

(*c*) By suction is meant the height through which a pump will actually draw water through its suction pipe. In practice, this is very commonly taken as three-fourths of the theoretical lift. Thus, at sea level, a pump is assumed to be capable of drawing water $34 \times \frac{3}{4} = 25\frac{1}{2}$ feet.

Ques. 14.—If track layers receive $3.45 per day, pick miners, 52 cents per ton, and entry yardage is $1.85 per yard, what will the several rates be at (*a*) a reduction of 5 per cent.; (*b*) at an increase of 5 per cent.?

Ans.—(*a*) If wage rates are reduced 5 per cent., the workers will be paid 95 per cent. of their former wages. In the example the reduced rates will be, for track layers, $\$3.45 \times .95 = 3.2875$, say $3.29; for pick miners, $.52 \times .95 = .494$, say 49 cents; for entry yardage, $\$1.85 \times .95 = 1.7575$, say $1.76.

(*b*) If wage rates are increased 5 per cent., the workers will receive 105 per cent. of their former wages. In the example, the increased rates will be, for track layers, $\$3.45 \times 1.05 = \$3.6225$, say $3.62; for pick miners, $.52 \times 1.05 = .546$, say 55 cents; for track layers, $\$1.85 \times 1.05 = \$1.9425$, say $1.94.

Ques. 15.—If an incandescent electric lamp should break in a body of gas (firedamp), would there be any likelihood of an explosion taking place?

Ans.—Yes. The tests of the Bureau of Mines have shown that it is practically impossible to break the globe of an incandescent lamp operating at ordinary mine voltages without producing an explosion of firedamp if the gas is present in the right quantity.

Ques. 16.—If an engine of 30-horsepower is doing a certain amount of work on a fan producing air, how many horsepower will be required to double the quantity of air under the same conditions?

Ans.—The increase in the horsepower required is proportional to the cube of the rate of increase in the quantity of air to be circulated. Thus, to double the quantity of air will require the expenditure of $2^3 = 8$ times the original horsepower. The original horsepower was 30; double the quantity of air will require $30 \times 8 = 240$ horsepower.

Ques. 17.—(*a*) What voltage would you recommend in a coal mine? (*b*) Why?

Ans.—(*a*) 250, although much higher pressures may be used under proper conditions.

(*b*) For haulage, coal cutting, etc., this voltage is preferred because contact with current carrying wires is less likely to cause a fatal shock. That is, the low voltage is preferred to the high, because it is safer. On the other hand, pressures as high as 3,000 volts alternating current may be safely carried on feed-wires, if these wires are carefully insulated and are laid in return air-courses or similar places where men do not travel. These high-pressure currents are transformed at a properly equipped station into 250 volts direct current for use at the face.

Ques. 18.—Of three different airways, rectangular, square, and circular, all of the same length and area, which will carry the most air with the same power, and why?

Ans.—Because the power required to circulate the air is proportional to the resistance of the airway, and because this resistance is proportional to the rubbing surface, the form of airway offering the least surface to contact with the air, the area remaining the same, will permit the passage of the greatest amount of air for the same expenditure of power.

Since the three airways have the same area and length, their rubbing surface is proportional to their perimeters; the rectangle has the greatest perimeter and will pass the least air, and the circle has the smallest perimeter and will past the most air. The perimeter of the square airway and the quantity of air passed by it are intermediate between those of the rectangular and square airways.

Ques. 19.—What is the pressure producing the circulation in a square airway, 100 square feet in area and 2,000 feet long, the velocity being 500 feet per minute?

Ans.—The quantity of air in circulation is

q = area × velocity = $100 \times 500 = 50,000$ cubic feet per minute;

l = length of airway = 2,000 feet;

k = coefficient of friction = .0000000217;

o = perimeter = 40 feet, since each side of the airway is 10 feet;

a = area of airway = 100 square feet.

Substituting in the formula,

$$p = \frac{k\,l\,o\,q^2}{a^3}$$

$$= \frac{.0000000217 \times 2{,}000 \times 40 \times 50{,}000^2}{100^3}$$

= 4.34 pounds per square foot.

Ques. 20.—(*a*) How would you set a post on a grade? (*b*) What purposes do caps serve with props?

Ans.—(*a*) Posts set on a grade or pitch are set nearly at right angles to the slope but their tops are inclined slightly uphill, so that any slipping of the roof downward will cause them to bind more tightly in place.

(*b*) As it is impossible to cut posts to the exact length necessary to cause them to stand upright by binding against both the roof and floor, caps are driven between them and the roof to hold them (the posts) in place.

Another important purpose of caps is to bring a greater area of roof to bear upon the post and thus to hold up a greater amount of rock.

Legal Decisions on Mining Questions

Miners May Legally Join Labor Organizations.—(Federal, West Virginia) In a recent case tried in the United States District Court of West Virginia, the question arose as to the right of an employer of mine labor to require that men employed sign a contract not to become members of any labor organization. The Hitchman Coal and Coke Co., on employing miners, required them to sign a contract declaring that they were not members of the United Mine Workers of America and would not become so while employes of the company, which agreed to run its works non-union, and that if at any time during the employment an employe should become connected with the United Mine Workers of America or any affiliated organization he agreed to withdraw from the employment of the company. The suit was brought by the Hitchman company against John Mitchell, a miner to restrain him from attempting to organize the workers employed in the Hitchman mines. The District Court granted the company a permanent injunction and the case was taken to the United States Circuit Court of Appeals. Here the decision of the lower court was reversed on the theory that such a contract did not bind the employes not to join the union, but only provided for termination of the contract in case they did so; and hence solicitation of such employes and inducements held out to them to join the union, by lawful and persuasive methods, not coercive nor intimidating, did not constitute an unlawful interference with such contract of employment. The court said: "The ancient English rule that labor unions were unlawful does not prevail in the United States in view of the changed conditions existing; the rule being now settled that labor may organize for its own protection and to further the interests of the laboring classes, and may strike and persuade and induce others to join then by peaceable means, being only subject to legal restraint by injunction when they resort to unlawful means to cause injury to others to whom they have no relation, contractual or otherwise. So long as the United States permits aliens to immigrate, a large majority of whom are uneducated laborers, it is the duty of the government to afford them equal protection under our Constitution and the laws pursuant thereto, including the right to combine to improve their condition. . . . . Since members of a trade union have a lawful right to induce persons employed in the same general business to join the union in order to secure as high a wage as possible, compatible with the successful operation of the business, a combination to accomplish such purposes by peaceful and lawful methods, so long as they refrain from resorting to unlawful measures to effectuate the same, does not constitute a conspiracy."—*Mitchell vs. Hitchman Coal and Coke Co., 214 F. 686.*

Must Sprinkle Passageways in Mine.—(Federal, Illinois) The Illinois Mining Law places a duty upon mine owners and mine operators to sprinkle all dusty haulageways, passages, and roads in a mine at such intervals as required by the state mine inspector. The plaintiff, a miner employed by the Eldorado Coal and Mining Co., operating in Eldorado, Ill., brought suit against the company to recover for personal injuries which he received while at work in the company's mine. He alleged in his pleadings that the defendant company had failed to sprinkle the passageways of its mine as prescribed by the law, that an explosion occurred, and that the dense dust which arose in consequence thereof caused him to become suffocated, such suffocation bringing about a serious illness which left his general health greatly impaired. Upon a trial of the cause in the lower court (District Court, Eastern Division of Illinois) a judgment was entered for the plaintiff in the amount of $2,500 and the defendant company took an appeal to the United States Circuit Court of Appeals, alleging that the judgment was contrary to law. The Appellate Court affirmed the decision of the lower court on the ground that the plaintiff was entitled to recover for the injury which was caused through the negligence of the defendant company. Judgment affirmed.—*Eldorado Coal and Mining Co. vs. Mariotti, 215 F. 51.*

Location of Entries of State Lands. (Federal, Kentucky) Under the law of Kentucky, in locating an entry of state lands the court cannot look beyond the patent, and although the certificate of survey may be considered for the purpose of correcting any mistake in transcribing the description into the patent, the entry itself, if admissible for any purpose, as it may be only in case of ambiguity in the description in the certificate and patent, is not controlling as to the boundary.—*Kentucky Coal and Timber D. Co. vs. Kentucky Union Co., 214 Fed. 590.*

Smokeless-Coal Operators' Association

At the annual banquet of the Smokeless-Coal Operators of West Virginia, given at the Bellevue-Stratford Hotel, in Philadelphia, on Tuesday evening, December 8, a handsome Tiffany pocket chronometer was presented by the members to Mr. John J. Tierney, of the Pocahontas field, who, for the past 3 years, has been the president of the organization. Mr. Tierney is one of the pioneer operators of this field, and this testimonial was presented by his fellow operators in recognition of his aid in the development of this splendid mining field, as well as his successful services in opening the market for the output, and the general improvement of mining conditions—a state of prosperity that has been shared jointly by the operators and their employes.

The presentation address was made by Mr. E. E. White, a well-known operator of the Virginia field.

NEW MINING MACHINERY

New Feedwater Regulator

The McDonough feedwater regulator shown in Fig. 1, consists of a special feed-valve, two headers, and two expansion tubes connected in parallel through a rigid linkage to the feed-valve stem. The use of two expansion tubes doubles the power of expansion and contraction, and the levers transmit the motion to the feed-valve in a ratio of 5 to 1. The turnbuckle and pointer indicator permit the very accurate adjustment of the valve; and further, the pointer indicator shows at each instant the position of the valve while the regulator is in operation.

The regulator is installed in an inclined position, wholly supported by the feed-piping with the connections made to the water column. In operation the lower end of the tubes are filled with water and the upper with steam. As the water falls or rises in the boiler, it correspondingly falls or rises in the regulator tubes, presenting a greater or less area of the tube surface to the hot steam causing them to expand and contract accordingly. The inclined position of the regulator gives the greatest variation in exposed tube surface for a given variation in water level and the greatest sensitiveness to variations in load.

Fig. 1

Individual Electric Lighting Plants for Steam Shovels

One of the problems which is encountered in operating steam shovels or cranes at night is to provide satisfactory illumination for them.

For night work adequate illumination is imperative, not only for the bank from which the shovel digs, but also around the shovels, to permit the necessary inspections and adjustments and to afford safety for the workmen.

The general illumination of the bank has been by a battery of powerful projector searchlights located on the opposite side from which the shovel digs, but to supply local illumination, about twenty incandescent lights are needed on each shovel, and to get current to them has proved quite a problem. One of the difficulties arises from the shovel being in motion. To overcome this, a method was devised of mounting a reel on each shovel, which carried a semiflexible cable that was unwound on to the ground as the shovel proceeded. One end of this cable was tapped on to a power circuit carried by poles.

The arrangement has been one of considerable annoyance to man-

Fig. 2. Turbogenerator Outfit for Steam Shovel Lighting

agers until in December, 1913, the Westinghouse Electric and Mfg. Co. furnished the Utah Copper Co. for trial one of their 1-kilowatt general utility turbogenerator outfits. This set was mounted directly on the shovel, being fastened to the under side of the main shovel frame and was supplied with steam from the boiler furnishing steam to the shovel.

Upon the installation of this set no attempt was made to supply the shovel with any electric power other than that produced by the turbogenerator, and this shovel with its little self-contained power plant was immediately freed from all interruptions caused by accidents to its supply of illumination. The shovel made such a good record for itself that the Utah Copper Co. purchased the turbo outfit furnished on trial, and about 4 months later ordered, for its other shovels that do most of the night work, six more outfits.

One of these sets will operate an arc lamp and a few incandescents at the same time, or about forty 25-watt incandescents alone. Practically no attention is required for the set because it is designed to operate for long periods without care. There are no delicate adjustments to make and every part is accessible for inspection.

Full rating is developed on steam pressures between 90 and 250 pounds. A governor controls the speed and keeps it uniform. A fixed resistance furnishes voltage regulation and a rheostat is provided to adjust the voltage when the number of lamps in use is varied. Hence, in spite of the abrupt changes in steam pressure and load that characterize shovel service, steady light is obtained.

Running a Fan Economically

Saving $480 annually by using a certain style mine fan, electrically driven, is an item that demands consideration.

The J. C. Stine Co. has placed on the market its patented disk fan driven by two-speed Westinghouse A. C. motors with a Link-Belt silent chain. The fan runs on Hyatt roller bearings. It is simple, cheap, compact, and efficient.

The manufacturers state that the silent chain is 98 per cent. efficient by actual test, making it an ideal driving medium. The roller bearings effect a saving of 25 per cent. in mechanical power, 75 per cent. in lubrication, and at least 90 per cent. in attention. The last named is peculiarly advantageous to fans situated as they sometimes are, remote from the mine buildings.

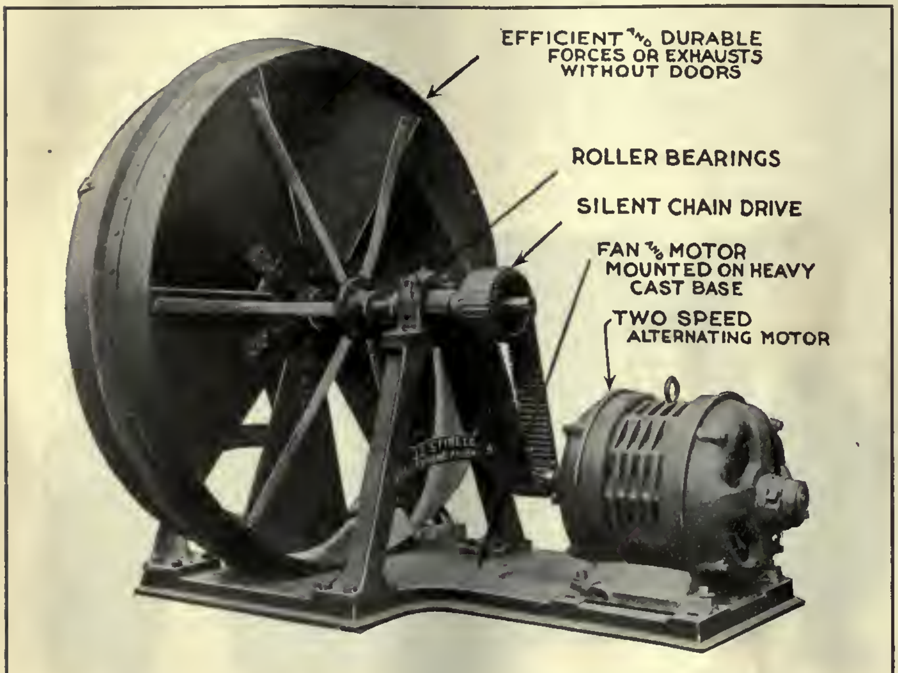

Fig. 3. Fan Driven by Two-Speed Motor

The two-speed motor is a striking feature of the equipment. There are but few mines that do not require less air at nights and on Sundays and holidays. Speed regulators on direct-current motors accomplished various results with a wide range of power, but with the increased use of alternating current, the standard squirrel-cage constant-speed motor was substituted. This answered every purpose save varying the speed.

To supply this deficiency, A. C. slip-ring motors have been used in connection with drum controllers. When running full speed this gives an efficiency of 87 per cent. but when reduced to half speed the efficiency drops to 37 per cent.

The two-speed induction motor is the desired medium. All that is necessary is a double-throw switch, the starting and stopping being done in the usual way.

To get an idea as to the difference in using the two motors, assume that a mine requires 70,000 cubic feet of air at 1 inch water gauge, when working the 10 hours during the day. The balance of the time, 14 hours, half of this quantity of air will suffice.

Under average conditions a 7-foot fan will deliver 70,000 cubic feet at 1-inch water gauge, running 425 revolutions per minute, requiring approximately 15 kilowatts. Assuming current can be generated or purchased at 1c. per kilowatt, this will make the cost 15c. per hour running full speed, or $3.60 per day. Taking the number of working days at 300, then the cost of operating at full speed, or with constant-speed motor yearly would be $1,080.

Now if the same fan with a two-speed motor is used and the fan run only 10 hours at full speed, the cost will be $1.50 for this period. If the fan is run at half speed for 14 hours, then the fan will deliver 40,000 cubic feet of air which will be ample for every requirement and the power consumption will drop approximately 3½ kilowatts or 50c. for the 14 hours, the cost for a full day's run being $2, against $3.60 where run at constant speed, making the cost of the operation $600, a yearly saving of $480. The saving in power alone would be about one-half the cost of the entire outfit. This varies with the cost of current and the diameter of the fan, but the same general difference holds good.

A Small, Portable Air Compressor

The small gasoline-engine-driven portable air compressor, shown in Fig. 4, has been developed by the Ingersoll-Rand Co., to meet the needs of those doing work requiring compressed air in small quantities such as the laying of gas and water mains, where air tools of various

types are used, for rock cutting, calking lead joints, drilling and riveting on steel pipes, tamping dirt, etc.

The compressor is operated by a single-cylinder gasoline engine of the two-cycle type. The air compressor, known as "Imperial XII," has a capacity of 45 cubic feet of air per minute at a pressure of 90 pounds, and is fitted with an air unloader, and the engine has a centrifugal governor.

Cooling is provided for by a gear driven pump and an automobile radiator with large tank capacity, serving both the compressor and engine. The radiator is assisted by a large fan.

An air receiver tested to 300 pounds water pressure and fitted with the necessary appurtenances is hung at one end of the frame and a 15-gallon gasoline tank is supported on a large tool box. The outfit complete weighs 1,600 pounds.

The Ingersoll-Rand Co. rates this outfit in terms of pneumatic tools of its make as follows: Three medium size "Little David" chippers; two "Crown" pneumatic picks; two "Little David" riveting hammers; one "Little David" wood boring drill or one metal drill; two "Crown" sand rammers; two small plug drills or one "Jackhamer"; one medium size "Imperial" hoist; ten small stone tools or six larger sizes.

TRADE NOTICES

Jenkins Bros. New Disk.—For years this firm, originators of the renewable disk valve, have made a most satisfactory and serviceable valve disk. Being manufacturers of high-grade valves, the perfect service of which depends upon the quality of the disk, they have been on the alert to obtain the highest degree of perfection for it, and recently they have perfected an improved disk compound which will hereafter be used in all Jenkins Bros. standard globe, angle, cross, and radiator valves. The disk will be known as No. 119. The composition is very hard but becomes tough and flexible in service when under steam pressure. It shows remarkable freedom from cracking and flaking and unrivaled durability in working steam pressures up to 150

Fig. 4. Portable Air Compressor

pounds. During the past year, the disk has been undergoing the severest possible tests in hundreds of plants, and engineers now using the No. 119 disks, in their installations pronounce them the most satisfactory disk for steam service ever brought to their notice. A complete service department is maintained by the firm to assist those in doubt to procure the proper valve or disk for the proper place. This department is at the disposal of each and every purchaser of any of Jenkins Bros. products without cost, and is but another evidence of their faith in the quality of their products, and all of this is certified to in their guarantee "satisfactory service or your money refunded." To engineers who are having trouble with other disks, and who desire to test the new Jenkins Bros. No. 119, a sample will be mailed free of charge on request.

Western Electric Co.—During the year 1914 the Western Electric Co. made new developments or improvements in various forms of electrical apparatus. Among these are standard packages of Interphone outfits containing everything necessary for their installation with complete illustrated directions for putting up the phones. There are four different combinations of these to suit different needs. The mine telephone has been developed in collaboration with the Federal Bureau of Mines, and the final design is said to meet successfully all conditions that may arise in underground rescue work. Loud speaking telephones for railway dispatching work have also been developed which relieve the operator of the necessity of wearing a head piece continuously. There have also been improvements in many other kinds of apparatus manufactured by the company.

The Western Electric News, published monthly for the employes of the Western Electric Co., has in its December number an interesting article on "Telephoning on the Isthmus." The article is by J. B. Reddig and is profusely illustrated. It contains also in brief the uses of the telephone in the war zone and the situation of their business abroad.

Fibreclad Wire Rope.—A new catalog describing marline covered wire rope, known as "Fibreclad," has been issued by the Waterbury Co., 80 South Street, New York. Fibreclad wire is a wire rope of standard construction, each strand served with tarred Russian marline. The rope is made in all grades of steel to meet the demands of the user. The manufacturers claim that it will outwear either wire rope of ordinary construction or manila rope; that it is easier to handle than bare wire rope, less cumbersome than manila, and the ultimate cost is less because of the saving effected in life and handling charges. They say: "In justice to yourself, you cannot pass this by saying, 'I don't think it adapted to our service.' Others have said the same only to find they were mistaken. Mental deductions frequently are averse to one's best interest and no one not having given this type of rope a practical test is justified in passing adverse judgment." Send for catalog.

"Hoisting Your Profits."—The colliery machine shop, located as it so often is at considerable distances from the large centers of population, must be equipped to handle all

ordinary repairs for almost any portion of the surface or underground equipment. Much of the machinery in use is so massive that practically all such shops are well equipped with chain hoists for the economical handling of the work. Every man in charge of these shops will be interested in "Hoisting Your Profits," a short story in pictures and words, of some of the ways in which Cyclone hoists are helping to a bigger day's business at a lower cost. The Chisholm-Moore Mfg. Co., Lakeside Avenue, Cleveland, Ohio, will willingly mail a copy to any one interested.

The Lagonda Mfg. Co., of Springfield, Ohio, has just issued a new Bulletin entitled, "Lagonda Boiler Tube Cleaners," in which are illustrated and fully described a new and interesting line of tube cleaners. Copy may be had upon request to the company.

Piston Rings.—A "Directory of Piston Ring Sizes" is issued by the Burd High Compression Ring Co., Rockford, Ill. This book describes the special form of piston rings and coupler for them, as made by that company, for which many advantages are claimed; and it also lists the sizes of cylinders, number of rings, etc., of practically all the automobiles, motor cycles, cycle cars, trucks, tractors, gas engines, etc., on the market, and therefore furnishes valuable information for the owner, repair man, or dealer in such machinery.

The Gifford-Wood Co., of Hudson, N. Y., will open an office in the Hudson Terminal Building, 30 Church Street, New York City. This office will be managed by Mr. A. W. Berghoefer, who will also have associated with him Mr. Joseph A. Boucher, both engineers who have been several years with the company. The territory that will be looked after by the New York office will include New York City and Westchester County, the southeastern part of the state of Connecticut, the southeastern part of Pennsylvania, and the southern states east of the Blue Ridge Mountains.

Enterprise Wheels.—In order to prevent confusion of trade names, the Enterprise Foundry and Machine Works now terms its product "Enterprise Wheels" instead of A. W. Whitney's wheels. There has been no change in the personnel of the company. Mr. Whitney will continue as heretofore to give his direct personal supervision to the manufacture of self-oiling and roller bearing wheels for the mining trade.

Catalogs Received

Precision Instrument Co., 102 Randolph St., Detroit, Mich. Catalog E, "Precision Recorders and Indicators."

Gardner Governor Co., Quincy, Ill. Circular, P–3 Boiler Feeders and General Service, 8 pages; Circular P–8, Duplex Power Pumps, 8 pages; Circular G–R–2 Gardner-Rix Vertical Air Compressors, 16 pages; Circular A–C–5, Gardner Horizontal Single-Cylinder Air Compressors, 14 pages.

Wm. Graver Tank Works, Chicago, Ill. Bartlett-Graver Water Softener and Purifier, 47 pages.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34–S, Small Power Driven Compressors, 16 pages; Bulletin No. 34–K, Class N–SO and N–SG Fuel Oil and Gas Driven Compressors and their application to the Unit System of Air Power Plants, 24 pages.

Lead Lined Iron Pipe Co., Wakefield, Mass. Lead Lined and Tin Lined Iron Pipe, 16 pages.

Lunkenheimer Co., Cincinnati, Ohio. Lunkenheimer "Clip" Valves, 10 pages; Lunkenheimer "Ferrenewo" Valves, 9 pages.

Chisholm-Moore Mfg. Co., Lakeside Ave., Cleveland, Ohio. Hoisting Your Profits, 16 pages.

Lagonda Mfg. Co., Springfield, Ohio. Lagonda Boiler Tube Cleaners, 32 pages.

Waterbury Co., 80 South St., New York, N. Y. Fibreclad Wire Rope, 23 pages.

Burd High Compression Ring Co., Rockford, Ill. Directory of Piston Ring Sizes, 67 pages.

Watt Mining Car Wheel Co., Barnesville, Ohio. General Catalog.

Canton Foundry and Machine Co., Canton, Ohio. Portable Floor Crane and Hoist, 31 pages; Sheet-Metal Machinery, 32 pages; Canton Alligator Shears, 19 pages.

Allis-Chalmers Co., Milwaukee, Wis. Bulletin No. 1088, Distributing Transformers, 16 pages; Bulletin No. 1089, Reversing Motor Planer Drive, 12 pages; Bulletin No. 1090, Motor Generator Sets, 16 pages; Bulletin No. 1091, Type OB–4 Governor, 8 pages; Bulletin No. 1904, Types OB–3 and OB–4 Governors, 4 pages; Repair Part Catalog No. 1903, Types OB and OB–2 Governors, 4 pages.

CALENDARS RECEIVED

The Roessler & Hasslacher Chemical Co., 100 William St., New York.

Weston Dodson Co., Inc., Bethlehem, Pa.

Milwaukee Western Fuel Co., Milwaukee, Wis.

Watt Mining Car Wheel Co., Barnesville, Ohio.

The Bittenbender Co., 132 Franklin Ave., Scranton, Pa.

University of Pittsburg's Extension Classes

The School of Mines of the University of Pittsburg has opened its University Extension classes in the mining towns of western Pennsylvania for the third year. Five classes have been organized to study the subjects of Mine Gases, Ventilation, Law, and Safety, in preparation for the fire boss examination. These are located at Uniontown, Mt. Pleasant, Leisenring, Yukon, and Russellton. In addition, a class in more advanced subjects to prepare candidates for the mine foreman examination is being conducted at Irwin.

The enrolment in the six towns is 157, exceeding that of the two previous years.

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Formerly Mines and Minerals

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E. E. White Coal Co. Mines

The Methods and Equipment of Some Well Managed Mines in the New River, W. Va., Field

*By George D. Evans**

THE Beckley bed in the New River coal field is noted for its many irregularities and the friable nature of the coal, which is of the smokeless variety. It presents many interesting problems in successfully mining and handling the coal. Naturally, the value of methods employed, including actual coal cutting, ventilation, drainage, haulage, tipple, and cleaning arrangements, nullifying dust, etc., are measured by results obtained. Gauged by this most practical of all tests, the E. E. White company's methods and equipment make a splendid showing.

When the Chesapeake & Ohio Railroad penetrated the New River coal field in the early seventies, that region attracted the attention of numerous mining men of the southern and middle anthracite fields of Pennsylvania. Later, when in 1886-87 the Norfolk & Western Railroad tunneled through Flat Top Mountain to Elkhorn Creek the coal was given still more prominence. As a result, mining engineers, operators, and mine managers of the Schuylkill anthracite field, who were quick to grasp opportunities, either bought or leased coal lands in the field and developed and worked them. The gradual absorption of the anthracite mines in the fields mentioned by large corporations, eliminated the individual operators, and many of them found a field for their activites in West Virginia. As a result, among the operators in the New River and Kanawha River fields will be found the names of such well-known anthracite region men as Beury, Cooper, May, Robertson, Goodwill, Thomas, McQuail, Luther, Tierney, Connell, Lathrop, Richards, Bickel, Leckie, and many

Fig. 1. Surface Works and Improvements at Glen White, W. Va.

*Civil and Mining Engineer. Pottsville, Pa.

others. E. E. White, the head of the E. E. White Coal Co., is a product of the western middle anthracite field, being the son of an old-time mine foreman of Mount Carmel, Pa.

Just as the English, Welsh, Scotch, and German miners brought into the anthracite fields many of the methods of European mining, the anthracite men are responsible for many of the methods adopted in the development and working of the West Virginia mines.

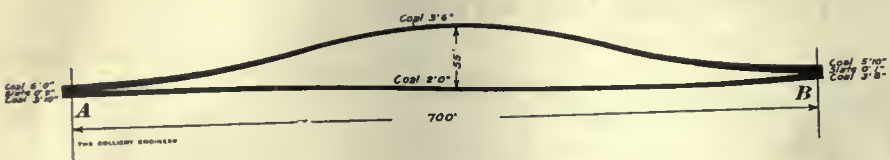

Fig. 2. Beckley Seam

The operations of the E. E. White company were developed by men whose early experience was gained in the anthracite regions. They had experience in coal seams lying at all angles of inclination from 0 degrees to 90 degrees, and of varying thicknesses. In the board of directors of the company there are two former operators, two present anthracite operators, one general manager and one mining engineer of the anthracite fields. In the operating force, not only officials and foremen, but many engineers, miners, and day men, are from the same fields.

The mines are situated in what has become known as the Winding Gulf field in Raleigh County, W. Va. The coal being operated is known as the Beckley bed after the largest town in the vicinity. The property of over 5,000 acres is leased from the Beaver Coal Co., composed mostly of Philadelphia capitalists, and of which Mr. E. T. Stotesbury is the president. This company owns between 45,000 and 50,000 acres in the field. The property is underlaid with another coal seam 270 feet below the Beckley which is 4 feet thick and known as the Fire Creek.

Nearly every one interested in the coal business in the Appalachian fields is familiar with the New River and Pocahontas coals, but that country between New River on the north and Tug River on the south is of comparatively recent development. The measures of what is known as the Middle Pottsville series, comprising the Raleigh sandstones and shales along New River, contain two workable seams, the Sewall and the Fire Creek. These measures thicken toward the south and in ascending Piney River, a tributary of New River, the Beckley bed, between the Sewall and Fire Creek, also thickens and is first worked at Stanaford mines.

Until a few years ago the Piney branch of the Chesapeake & Ohio Railroad was operated only as far as the mines of the Raleigh Coal and Coke Co., about 10 miles from New River, leaving a large territory to the south undeveloped until the late H. H. Rogers in 1906 completed the Deep Water and Tide Water railroads now known as the Virginian. This railroad together with the extension of the Chesapeake & Ohio lines, opened the Winding Gulf field.

One of the strong features in the development of the property of the E. E. White Coal Co. is that it is opened at two different points 3 miles apart and at each operation is served by both the Virginian and C. & O. Railroads, the former giving an almost unlimited car supply at all times, and excellent service to tidewater and the South, while the latter takes care of the trade to the Middle West and the Lakes as well as to tidewater. The selling agents are Castner, Curran & Bullitt.

Before going into the plans of operation and mining methods, a few words about the nature and characteristics of the Beckley coal may be of interest.

The following is an average analysis made by the United States Government chemist of coal taken from cars shipped by the E. E. White Coal Co.: Moisture, 1.40; volatile matter, 17.10; sulphur, .45; ash, 3.55; fixed carbon, 77.50; B. T. U., 14,850.

While there are no mines to my knowledge at which the Beckley coal is being coked, tests have been made which prove that it would make an excellent grade of foundry coke.

Were it not for the fact that for steaming purposes, this coal commands at all times and in all markets a good price, it would not be a profitable seam to work. It is doubtful if there is a seam of coal anywhere in West Virginia more difficult to operate on account of the irregularities in thickness and grades. The Beckley bed is split as shown in Fig. 1, the divider varying from as little as 1 inch in places to as much as 120 feet in others.

Fig. 2 shows an average section of the bed as found in many places.

Owing to the varying thickness of the divider the grades are particularly irregular in the upper split, which is the one generally worked wherever the thickness of the divider prohibits operating the two benches together. It is invariably the case that, where the splits are together in the low places or swags, both splits are thicker than on or near the anticlinals, of which there are many local to the bed.

Owing to these irregularities it is generally difficult to follow a fixed plan of operation, and in order to work economically and to the best advantage as to hauls, drainage, etc., levels must be carefully driven and the projected plans changed from time to time to meet conditions. Contours of the top rock are carried on the mine maps of the E. E. White Coal Co., the top being used because the top split is followed where the splits are widely separated.

While there are many local anticlinals and synclinals, taken over a large area, the coal has a general dip of about 2.5 per cent. from southeast to northwest. Glen White mines No. 1 and No. 2 are opened at the extreme northwestern part of

FIG. 3. CROSSING IN MINES AT GLEN WHITE

FIG. 4. MACHINE CUTTING ENTRY

the lease in order to take advantage of natural drainage and down grade for the loaded trips. They are opened by twin shafts, 29 ft. 5½ in. × 10 ft. 10 in. inside of the timbers, 310 feet deep and 440 feet apart.

The elevation at the top of the shafts is 2,180 feet above tide, the coal being 1,870 feet above tide.

The Stotesbury, or No. 3 mine, is a drift operation on the Winding Gulf, the coal cropping at an elevation of 2,080 feet above tide and 150 feet above the valley.

At Glen White the coal from both mines is being hoisted at No. 1 shaft by a pair of 24″ × 48″ first-motion engines with 8-foot and 10-foot conical drums, working in balance, and equipped with steam brake, steam reverse, and Nicholson automatic safety overwind. They were built by the Vulcan Iron Works, of Wilkes-Barre, Pa., and have a capacity of 300 tons per hour.

The shaft is equipped with Vulcan automatic cages dumping directly into the tipple. Although this tipple is designed for the preparation of all sizes of coal, at present it is being used for run of mine, the trade for prepared sizes being served from the Stotesbury tipple, No. 2 shaft, at present being used as an intake and tender shaft, is equipped with a pair of 10″ × 14″ second-motion hoisting engines for lowering rails, timber, and supplies into the mine and for hoisting men in case of emergency. One compartment contains stairs, and another the steam and pump discharge pipes. In case it ever becomes necessary, this shaft can be equipped for hoisting coal.

There is no steam used at No. 3 mine, the power being electricity conducted across the mountain from the power plant at Glen White. This plant contains six 350-horsepower Keeler water-tube boilers with a Cochran feedwater heater and suitable boiler feedwater pumps.

The main pumping plant at Glen White consists of a Goyne 24″ × 12″ × 36″ duplex steam pump at present running about 20 strokes per minute and discharging 70,000 gallons per 24 hours. Local sumps and swags are cleared by Deming portable triplex pumps electrically driven.

In the power house, which is stone with asbestos-shingle roofing, are the No. 1 shaft hoisting engines as well as the generators, etc.

Fig. 1 shows the power house, tipple, shops, and fan.

The electrical equipment which supplies power for all three mines is in three units, and consists of three 375 K. V. A. General Electric, 6,600-volt, 25-cycle alternators, each driven by an Erie-Ball 22″ × 24″ slide-valve engine at 187.5 revolutions per minute. There are one 300-kilowatt and two 150-kilowatt rotary convertors, with the neces-

FIG. 5. TURNOUT AT BOTTOM OF NO. 1 SHAFT

FIG. 6. OVERCAST ON MAIN HAULAGEWAY

sary transformers, etc., which deliver the power to the Glen White mines at 275 volts. There are also two 30-horsepower 220–110 volt Westinghouse oil-cooled transformers for town lighting.

A wood-pole transmission line 4 miles long conveys power at 6,600 volts to the No. 3 mine at Stotesbury. At the latter place the necessary transformers, convertors, etc., are housed in a stone building.

At Glen White the coal is hauled from the partings by four 10-ton Baldwin-Westinghouse locomotives and is gathered to the partings by six 6-ton gathering locomotives of the same make, and a few mules.

Fig. 3 shows three of the motors at Glen White.

At Stotesbury no mules are used, the hauling being done by electricity, and the equipment consisting of two 10-ton Baldwin Westinghouse motors and seven 6-ton General Electric gathering motors.

The mine cars at Glen White are steel with wood bottoms, steel lined, while at Stotesbury, where the coal is not so high, an all-steel car is used, giving additional headroom of 2½ inches without loss of capacity.

Both pick and machine mining are practiced. At Glen White it is done by two Sullivan room-and-pillar machines and two Morgan-Gardner truck-mounted center cutters. At the Stotesbury operation, machines are used throughout except when robbing close to the outcrop. There are in use at this mine two Morgan-Gardner center cutters, five Sullivan ironclads, and one Goodman shortwall machine. Cutter bars from 6 to 8 feet long are used, depending on conditions. Longer cutter bars have been tried but rejected on account of the difficulty encountered in handling the machines where bottom is shot up for the roadway.

Fig. 4 shows a Morgan-Gardner truck-mounted, center cutter, working in an entry at Glen White.

Fig. 7. Stotesbury Tipple

Owing to the irregularities in the Beckley seam, it is difficult to adhere strictly to a fixed plan of operation, but the mines of this company are operated on a modified form of the four-entry, and panel system, While the coal at Glen White is hoisted at No. 1 shaft, the two mines are worked separately, being connected close to the shaft bottom for the distribution of cars and for ventilation and outlet.

Fig. 5 shows the loaded turnout at the bottom of No. 1 shaft, where one set of entries is being driven south toward Stotesbury, another set southeast following the direction of greatest rise of the coal, while the main entries from No. 2 shaft are being driven due east, thus opening the acreage in a fanlike shape. Six drifts at the No. 3 mine open the frontage on the Winding Gulf and are operating toward Glen White.

From the main entries, branch entries are turned right and left, and from these the panels are driven. Twenty-five rooms are generally worked to a panel. They are opened on 60-foot centers and are driven from 16 to 20 feet wide for 300 feet, leaving a room pillar of from 40 to 44 feet. A pillar of 100 feet is left between the faces of the rooms and the airway of the panel above, and one of 150 feet or 200 feet (depending on the height of coal) between the first and last rooms and the main entries below and above; and as soon as the rooms are finished the room pillars are drawn back. As the pillars are being removed, the rails and ties are recovered, and also many of the posts, by means of a chain-post puller. By the immediate removal of the pillars much labor, track, and timber are saved, while the entries on the three sides are protected by the chain pillars which are recovered afterwards as the entry above is robbed. By this method of narrow rooms and thick pillars, a very small percentage of the coal is lost.

Entries are driven from 12 to 16 feet wide, according to the height of the coal; the return airways are made no less than 12 feet wide and in low coal are driven wide enough to allow a minimum area of 60 square feet.

No. 2 shaft is used as the main intake airway and a 24′×6′ Guibal reversible fan, built by the Vulcan Iron Works, is exhausting in No. 1 shaft. It is driven directly by a Vulcan 18″×30″ engine and has a capacity of 300,000 cubic feet of air per minute. The fan is enclosed in steel and masonry, and the engine house is stone with reinforced concrete roof. The fan is set 40 feet back from the top of the shaft airway, which is covered with explosion doors and has an area of 140 square feet. At the present time the workings of the Glen White mines, covering an area of about 600 acres, are being ventilated by a current of 150,000 cubic feet of air per minute, with a water gauge reading of only 1.3 inches.

Close to the shaft bottom the intake is divided into three main

splits, which are further subdivided allowing each entry a supply of from 20,000 to 30,000 cubic feet of air per minute. All permanent stoppings are stone set in cement mortar, and a force of masons is kept constantly at work building these stoppings. The return air crosses the main haulageways via overcasts of stone and brick masonry and reinforced concrete, one of which is shown in Fig. 6.

All entries and rooms are connected by breakthroughs at a maximum distance of 80 feet, and where necessary brattice is carried from the last breakthrough to the face. In no part of the mines is there left a blank end, every entry or room when stopped being connected right at the face to the adjoining entry or room, thus keeping the air circulating directly across the face of the workings. Each panel before being robbed is connected at one or more places, furthest from the intake, with the return airway of the entry above, so that there is always a current of fresh air passing over and through to the faces.

Though these mines are not classed as dusty, the roads in most parts being so moist that they are packed hard and the roof and ribs showing a precipitation nearly everywhere, the management is putting forth every effort to evolve a dependable system of humidification. Radiation in the form of 3,000 feet of 2½-inch pipe arranged for the purpose and heated by exhaust steam from the fresh-water pump, and 600 feet of 6-inch uncovered steam lines to the pumps, heats the air as it passes down No. 2 shaft.

Jets of live steam furnish additional heat and moisture at the shaft bottom. A short distance beyond these jets the air passes through an entry in which the water is dammed back for several hundred feet to a depth of about 2 feet. This water is heated by exhaust steam from the main pumps and gives off warm vapor in dense volume which is carried along with the intake. Sprays of fresh water placed over the dam at intervals supply additional moisture and help to replenish the water in the dam.

Hygrometrical readings are taken regularly in all parts of the mine and in the upcast airway, from which careful calculations of the humidity are made. To January 1, 1915, in no place in the mine has there been a reading of less than 95 per cent.

Regardless, however, of these satisfactory mathematical results and of the seasons of the year, the dryer parts of the mines are regularly and systematically sprinkled.

The company is using as its standard sprinkling outfit a Weinman 2-inch centrifugal pump driven by a 5-horsepower motor and mounted on a truck with mine car running gear. This is used in connection with one, two, or three, tank cars, depending on grades, of 750 gallons capacity each, from which the water is thrown in a spray against roof, sides, and floor while the train is slowly moved along the entries by one of the locomotives.

The force of the spray is so great that in passing a break the water is thrown a distance of 40 feet from the entry. The tank cars are loaded from diamond drill holes originally sunk for prospecting purposes before the mines were opened. Two of these outfits are sufficient to keep the two mines thoroughly sprinkled.

FIG. 8. LUMP COAL SHAKER

FIG. 9. CAR OF COAL BEING LOADED

As an additional precaution against dust the company is planning a series of bore holes and a system of piping and sprays throughout the mines.

From the time the first pick was sunk in the opening of these mines the motto of the company has been "Safety First" and there is no danger common to coal mining that is not carefully watched. The main haulage roads in all three mines are lighted by electricity, and neatly lettered sign boards are posted in conspicuous places bearing warnings of dangerous practices and pointing out the direction to the exits.

In addition to the general inside foreman, a man of long and varied experience, and his assistants, each of whom has a certificate of efficiency from the state, the company

Fig. 10. E. E. White Coal Co. Engineer's Report, Glen White, As of June 30, 1914

Mine No. 1	No. Feet Driven During Month	No. Feet Driven Previous Month	Total Length of Entry to Date	Section of Vein: Draw Slate	Section of Vein: Draw Slate: Slate	Coal	Boney Coal	Bone	Coal	Black Rash or Bone	Parting	Coal	Bone or Parting	Coal	Slate	Coal	Total Coal	Total Waste	Top: Kind of Top	Top: Good or Poor	Top: Taking Down For Roadway	Bottom: Kind of Bottom	Bottom: Taking Up For Roadway	Dip of Vein	Direction of Entry	Cubic Feet Air Per Minute	Relative Humidity Per Cent.	Number of Working Places	Number of Miners Working	Remarks
Left main entry............	75′	60′	1,993′		9″	2′-11″	1″		1′-9″		9″	1′-4″	7″	1′-10″			7′-11″	2′-1″	Sandstone	Good		Slate		1° ahead	S 55° E	30,000	100	4	2	
Right main entry...........	30′	100′	2,407′			2′-11″	1″		1′-3″								4′-3″		Sandstone	Good		Slate	2′-0″	2° back	S 55° E	30,000	93	9	6	
Fifth south entry...........	138′	257′	958′			3′-4″	1″		2′-0″								5′-5″		Sandstone	Good		Slate		Level	S 35° W	30,000	97	8	6	No robbing being done in No. 1 shaft workings
Fifth south No. 1 panel......	60′	63′	375′		9″	3′-0″	1″		2′-0″								5′-1″	9″	Sandstone	Good		Slate		3½° back	S 55° E	30,000	97	9	2	
Fifth south No. 2 panel......	80′	7′	87′			3′-6″	1″		1′-11″								5′-6″		Sandstone	Good		Slate		2° back	S 55° E	30,000	97	2	2	

383′, No. Ft. entry driven, 487′ } Previous
77′, Avg. Ft. per entry, 97′ } month

5′-7″, average coal in entries
4′-5″, previous month

Robt. F. Roth, Assistant Engineer

employs a man whose title is safety inspector, and whose duty principally is to find fault. He is expected to visit as much of the mines as possible every day, keep tabs on the ventilation, mining, timbering, etc., report faulty conditions, and instruct both company men and miners in good and safe practices and warn them against bad ones. He shows the less experienced miners how a good, deep cut will bring better results than a shallow one, where the holes should be placed, and how loaded, tamped, and fired. He has full power to discharge any man for the violation of the mining laws or the rules of the company. Shooting off the solid or tamping with slack or "bug dust" means immediate discharge if the offender is caught. Clay or tamping is hauled by the company to or near every working face, and only permissible explosives are used. As the safety inspector is liable to appear in any part of the mine at most any time, often entering a working place just after the foreman or fire boss has gone out, the laws are very seldom violated.

Every entry and room in the mines is driven on lines set by the engineers; surveys are made regularly, and not only the foreman, but each fire boss as well, is regularly provided with an up to date revised blueprint of his section of the mine.

The engineer in charge, in conjunction with the mine foreman, makes periodical air measurements and relative measurements of humidity, which are included in a general report which he makes to the general manager each month. This report includes the distance each entry is driven during the month and total distance driven to date, a section and the dip of the bed at the face, the nature of both top and bottom; and the course on which the entry is being driven, the air measurement, the relative humidity, number of working places and number of miners working. He also makes a monthly room report showing the specified and actual width of rooms, and whether they are on line, and the thickness of the coal at the face.

Figs. 10 and 11 are samples of these reports.

One of the most interesting plants of the E. E. White Coal Co. is the Stotesbury tipple built by the Link Belt Co., of Philadelphia, a general view of which is shown in Fig. 7.

Having in mind the extreme friability of the coal to be handled and the desire to ship as large a proportion of lump coal as possible, the officials of the coal company and the engineers of the Link Belt Co. designed this tipple to handle the coal with the least possible breakage. Figs. 8 and 9 showing the lump coal shaker and a car of lump coal being loaded attest to the results achieved. A consignment of lump coal was recently made from this tipple to one of the large ship

Fig. 11. Engineering Department, E. E. White Coal Co. Report of the Driving of Rooms in Glen White Mines, Nos. 1 and 2

Name of Working Place	Number of Room	Machine Driven	Thickness of Coal Seam	Specified Width of Place Feet	Width of Place, Feet: This Examination	Width of Place, Feet: Previous Examination	No. Feet Off Line: This Examination	No. Feet Off Line: Previous Examination	Remarks
No. 1 shaft...	5	Sullivan	4′	24′	26′	31′	O. K.		Slight excess
Right main...	6	Sullivan	4′	24′	24′	28′	O. K.		O. K.
Entry........	8	Sullivan	4′	24′	24′	29′	O. K.		O. K.
No. 2 shaft...	3	Morgan-Gardner	9′	16′	19′	18′	O. K.		Excessive
	7	Morgan-Gardner	9′	16′	17′	17′	O. K.		Satisfactory
No. 2 shaft...	1	Sullivan	4′	24′	23′	20′	O. K.		Very satisfactory
Third, south..	2	Sullivan	4′	24′	19′	20′	O. K.		Very satisfactory
Pick Work...									
No. 2 shaft...	10		5′	20′	25′	21′	O. K.		Too wide
Third, north..	11		5′	20′		23′	O. K.		
No. 1 panel...	16		5′	20′	27′	24′	O. K.		Entirely too wide
No. 2 shaft...	3		5′	20′	19′		O. K.		O. K.

Date of this examination, June 30, 1914.
Date of previous examination, May 26, 1914.

Robt. F. Roth, Assistant Engineer

yards to be used for the speed test of the Argentine dreadnaught "Moreno." It was said to be the finest coal ever received at that yard.

The coal is delivered from the drifts to two turnouts, one on each side of the head-house, each side feeding to a Phillips kick-back dump. The coal from each car as it is dumped is caught on a drop apron and inspected for slate before it is delivered to a traveling picking table by means of a reciprocating feed which allows the slack to fall on the table first, forming a cushion for the lumps. The slate and bone, of which there is very little, is eliminated on this picking table which delivers the coal to a retarding conveyer 325 feet long by which it is carried down the hill and passed over ¾-inch stationary screw bars to remove the slack. It is then separated into lump, egg, and nut by means of shaker screens having an easy reciprocating motion. The lump and egg are loaded into the cars lengthwise by loading boom conveyers which can be raised or lowered as desired, so that the coal has the least possible fall. An extension to these boom conveyers acts as an additional inspection table from which any doubtful looking lumps are removed.

When it is desired to load run-of-mine coal a 17-foot parallel gate is opened above the shakers, allowing the coal to be delivered directly into the small bin and thence to the cars. All the machinery is driven by electric motors.

[In our next number, the excellent and successful welfare and educational work carried on by the E. E. White Coal Co. will be described and illustrated.—Editor.]

Cherry Lumber

Cherry is the wood most used as a backing for the metal plates from which illustrations are printed in magazines and periodicals. It is chosen above all others because it holds its shape, does not warp or twist, works smoothly, and does not split.

Concrete in Mine Work

Method of Building Strong and Tight Concrete Stoppings of Cheap Material Such as is Usually at Hand

By Sim Reynolds

Considering the steadily increasing cost of lumber, which will never decrease, mine owners and mine managers are naturally eager for any substitute proven of equal efficiency or better.

For mine stoppings, overcasts, etc., a good deal of brick is being used, and in some mines more or less concrete, the latter not as extensively as it will be when mine managers become more conversant

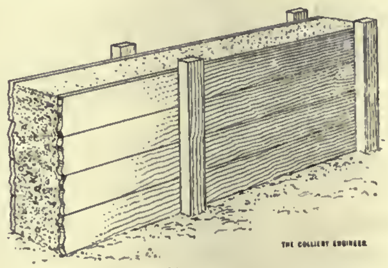

Fig. 1

with its merits, and its adaptability to many phases of mine work. While this rarely comes to a man without an actual trial, yet the next thing to it in point of conviction is to show the actual work done in another man's mine.

The writer has used concrete in mine work in building overcasts, stoppings, door casings in main haulways, etc., and has found it better than brick in point of utility and economy. He also found that it could be substituted for wood with but a slightly increased cost. And as mining operations become larger the use of wood must inevitably give way to something more substantial that will remain on duty as long as the mine shall last. This must inevitably be accepted, no matter how cheap wood may be. For instance: what prodigious power would be needed originally in a mine as extensive as some in Washington County, Pa., if only about half of the air produced reached the workings, on account of decaying or broken wood stoppings along the miles of headings? In many mines not more than 50 per cent. of the air registered at the intake reaches the face, and almost invariably the brattice work in each of these mines is constructed on the principle of "It'll last a while, anyhow." But where it is absolutely essential that the air-current reach the men in its fullest possible force, such conditions cannot long exist, and every suggestion that offers reduction in cost and increase in efficiency is welcomed. It is chiefly to such mine management that this article is directed, to those men who must follow the heading with a stopping that will stay, and that at every 20 yards or so.

In the first place consider the 8-inch brick stopping in ordinary use in the 54-foot sectional area breakthrough of the Pittsburg bed. This will require approximately 600 brick. Estimating the price as $7 the thousand the material for an ordinary stopping (brick and mortar) will approximate $5. Of course this will vary as will the cost of putting it up, but a conservative estimate of a brick stopping such as indicated will be about $7.50. By actual tests, and under normal conditions as to cost of material, it has been proven that a concrete stopping can be built quite as, if not more, substantial, at a less cost both for material and construction.

One method is to fill in the concrete between wood forms set about 8 inches apart as shown in Fig. 1. And although when finished and thoroughly "set" this makes a good stopping for ordinary purposes, it is rather inconvenient to build. On account of the upright posts, which are necessary to prevent the forms from bulging when concrete is poured in, it is impossible to place the boards at full length. There is also more or less trouble in filling the last few inches at the top. The

writer has tried this, as well as other methods, with complete success, but the concrete and stone wall shown in Fig. 2 is the better of the two.

An ordinary wooden brattice is put up immediately following the advance of the entry. Later on, this brattice acts as one side of the form needed to build the permanent concrete stopping, and there is usually enough stone in the immediate vicinity to build the retaining wall. In extremity, soapstone, or even bone coal, can be used. The wall should be started at such a distance from the stopping as to allow 6 or 8 inches of good concrete between the wood brattice and the inside of the first layer or course of stone, and the concrete should be filled in carefully on every successive layer to the top. If there is 4 to 6 inches of concrete between the forms and the stone at the top, the result will be a satisfactory stopping, or a thickness of 14 to 16 inches through concrete and stone at the bottom, and 8 to 10 inches at the top. When the concrete is sufficiently set the wooden brattice can be taken down and reused, and so on until worn out. The care used in setting up the wooden partition originally, and the care used in taking it down has a determining effect on the life of the boards.

It has been found preferable to use the wood so as to have the smooth side of the stopping toward the main entry, and the stone side on the air-course, where the double-entry system is used; because if there be any leak, this readily admits of its stoppage.

The chief claims for this method are simplicity of construction; and strength of the completed job. Any ordinary mine laborer can do the work, as with the wood brattice already up there is nothing to it but a rough stone wall followed with a few inches of concrete filled in between. The soft concrete fills all crevices as the wall is built, cementing the whole into a solid mass. It can also be still more solidified by a little tamping as the layers of concrete are poured, and the coagulation of the cement mass made more nearly perfect, if the lower part be not allowed to set before the top. With the necessary material at hand a good laborer will build such a stopping as I have described in a half day. Counting the other half as necessary for gathering supplies (which, with a certain system of placing supplies would be much re-

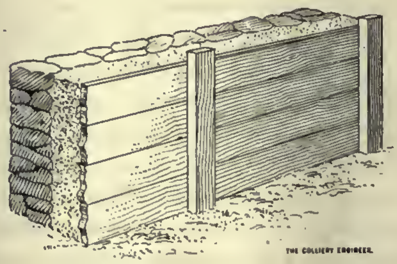

Fig. 2

duced or totally eliminated) there would still remain a big difference in favor of the method compared with brick.

Material used in a 54-foot stopping follows: Cement, 4 bags; rough river sand, or ordinary smooth sand with ashes, 6 bags; in the proportion of cement, 1 part; sand, 2 parts; ashes from boiler room, 4 parts.

Cost of brick stopping, including labor, $7.50; cost of cement stopping, including labor, $4.

The following aids have also been found useful:

If the boards on the wood frame be greased well with car oil they leave the concrete more readily, and make a smoother job.

Care must be taken to avoid air holes in the finished stopping. Insist on good tamping being done, either by the laborer setting the stopping or by a helper.

It is best to keep the same man, or men, at this work if possible.

No mixing box is necessary. A suitable place can be cleaned off on the mine floor.

Large clinkers should be avoided in the ashes used.

Cement should not be taken into the mine until the place for using it is ready. The ashes and sand supplies should be deposited in suitable places during times when other work is at a standstill.

Electric Shot Firing in Oklahoma

Secretary Lane, of the Interior Department, has approved the recommendation of the Commissioner of Indian Affairs and the Director of the Bureau of Mines that the order of May 4, 1914, requiring the use of permissible explosives in the coal and asphalt mines on the segregated coal and asphalt lands belonging to the Choctaw and Chickasha Nations in Oklahoma, or in lieu thereof, the use of an electric shot firing system operated from without the mine, shall go into effect January 1, 1915.

The Department in making this order issued the following statement:

"This order was issued with the twofold purpose of increasing the health and safety of miners, and protecting the property interests of the Indian lessors against damages by mine explosions or mine fires, and by the terms thereof, was made effective August 1, 1914. The order was later suspended until January 1, 1915, so as to afford opportunity for demonstrations of permissible explosives in Oklahoma by engineers of the Bureau of Mines and for investigations of the use of electric shot firing systems with especial reference to Oklahoma conditions.

"In the interval between August 1, and the present date, the Bureau of Mines conducted demonstrations in some 12 typical coal mining operations out of the 44 coal mines on segregated lands, and made an exhaustive study of electric shot firing systems.

"At the conclusion of these field demonstrations, a conference was called at Pittsburg, Pa., on November 30, for the purpose of permitting the miners and operators to concretely present such objections as they might have to the enforcement of the order. The matter was quite fully discussed at that time, but as both the operators and miners failed to submit the facts upon which their objections were based, they were given until December 15, in which to submit their views in writing.

These statements have now been received and have been carefully examined.

"After a thorough consideration of this order in all its bearings, both as regards the miners, operators, and Indian lessors, it is ordered that the same be made effective January 1, 1915, and that the representatives of both the operators and the miners be advised at once that the Bureau of Mines, through its local representative at McAlester, Okla., will receive and act upon individual applications from the operators, for an extension of time within which to take steps to comply with the terms of such order. A liberal time will be allowed for this purpose so that no undue hardship will be imposed.

"This recommendation is based upon the following considerations:

"First. The depressed financial condition, which makes it difficult for the coal companies to raise any extensive amount of money at the present time in order to install mining machines, which should be done in order to use permissible explosives to the best advantage.

"Second. The fact that electric power is not available at present to a considerable number of the operators and that it will necessarily take some time before suitable arrangements to this end can be made.

"Third. The operators on segregated lands are subjected to a very keen competition with the coal produced in the non-union mines of Arkansas and Colorado, where mining costs are lower, and also with the coal mines in Okalahoma on the non-segregated lands which are peculiarly favored in respect to absence of gas and better working conditions. The market for the coal produced from the segregated land is also very much restricted by means of great increases in the production of oil and natural gas in Oklahoma, with which on the score of cheapness, and efficiency in use, coal cannot compete.

"Fourth. The change in explosives will probably compel a readjustment of the understanding with the miners with reference to working conditions, and a reasonable time should be permitted for the working out of satisfactory arrangements, without causing undue hardship to either side, or reducing the royalty returns to the Indians."

Coke-Oven Accidents, 1913

*Compiled by Albert H. Fay**

The number of coke establishments in the United States is practically 575, with slightly over 100,000 ovens. The Bureau's report embraces practically one-half of the operators, and 80 per cent. of the ovens, the number reported to the bureau as active being 67,526, and in addition 12,450 ovens were reported idle. While the accident figures thus collected are not complete for the entire industry, yet they are thoroughly representative. No distinction has been made concerning the type of ovens in use.

A serious accident is considered in this report as one that would disable a man and keep him from duty 20 days or more. This class includes such injuries as broken arms and legs, loss of eye, and severe cuts and bruises.

A slight injury is considered as one that involves a loss of more than 1 day and less than 20 days. Under this class may be placed such injuries as cuts, sprains, mashed fingers, bruises, dirt in eye, slight burns, effect of powder smoke, etc. Of course any slight injury may become infected and thus result in a serious accident as defined above.

It will be noted that 13 fatalities resulted from accidents caused by cars, larries and motors, and seven fatalities were caused by railway cars and locomotives, making a total of 20 deaths due to haulage or transportation systems, representing 43 per cent. of all the fatalities. Six fatalities were due to coke drawing machines, representing 13 per cent. of the total, and 11 per cent. to electricity.

Of the serious injuries 26 per cent. were due to haulage systems; 23 per cent. to falls of persons. Of the slight injuries 8 per cent. was due to haulage systems; 12 per cent. to falls of persons; 14 per cent. to hand tools, and 16 per cent. to burns.

Since 43 per cent. of the fatalities at coke ovens are due to haulage systems, greater care and precaution should be taken to safeguard the employes who operate or work adjacent to transportation equipment. Inasmuch as electric haulage is used extensively, a large percentage of the electrical accidents may also be classified with those resulting from haulage systems, or a total of approximately 50 per cent. of all fatalities. It is in this department of the coking industry that there appears to be an excellent field for accident reduction.

These plants employed 24,345 men and of this number 46 were killed, 342 seriously injured, and 2,172 slightly injured.

COKE-OVEN ACCIDENTS, IN THE UNITED STATES, 1913

	Killed	Seriously Injured	Slightly Injured
Causes:			
Cars, larries, and motors	13	48	74
Railway cars and locomotives	7	41	109
Coke-drawing machines	6	19	41
Electricity	5	8	35
Falls of persons	4	78	263
Hand tools		22	314
Suffocation from gases	1	1	26
Burns	2	36	343
Other causes	8	89	967
Total	46	342	2,172
Accidents by states:			
Alabama	3	37	497
Colorado	2	4	6
Illinois	2	45	544
Kentucky	1	6	39
Ohio		3	54
Pennsylvania	28	138	426
Tennessee		1	2
Virginia	1	4	4
West Virginia	1	3	26
Other states	8	101	574
Total	46	342	2,172
Number per 1,000 employes:			
Coke ovens, 1913	1.89	14.05	89.22
Quarries, 1913	1.72	10.28	62.55
Metal mines, 1913 (surface only)	2.06	21.75	92.13

Culm occupies 46 per cent. more space than solid coal. This was obtained from an experiment in which a cubic foot of pulverized coal filled a box 12 in. × 12 in. × 17½ in. Experiments also show that there was a settlement of about 31 per cent.

*U. S. Bureau of Mines.

Multistage Centrifugal Pumps

Principles Governing Their Construction and the Methods Adopted by Different Makers to Attain the Same Results—Calculations

Written for The Colliery Engineer

THE ease with which electricity is transmitted and converted into power, the introduction of the steam turbine, and the great improvements recently perfected, almost compelled steam pump makers to enter into the manufacture of centrifugal pumps. Although the first centrifugal pumps wasted power, their simple construction and the ease with which they were driven by simple rotation, led from one improvement to another, until at the present time centrifugal pumps, under certain conditions and in certain places, are more efficient than steam pumps. The term efficiency as used implies "the power consumed to perform a given amount of work," but there is another definition of efficiency just as important, and that is the economy in the cost of labor and maintenance. As an example, in one Pennsylvania mine there are two steam pumps raising 21,000 gallons of water per hour to a height of 337 feet. At the same mine there is a four-stage centrifugal pump which forces 48,000 gallons of water per hour to the same height. The steam pumps require 55 pounds steam per horsepower, the centrifugal pump 35 pounds steam per horsepower. Basing the comparative economy on cost of repairs, labor supplies, and steam used for pumping the respective quantities of water mentioned, there was a saving of 74 per cent. in 9 months.

The introduction of electric power and its application to centrifugal pumps suggested to some one that they be worked in stages, that is one pump be placed in a mine at the bottom sump to raise water to a lodgment higher up the shaft, say 100 feet.

At the first lodgment a second pump was to be installed which would raise water to a second lodgment 100 feet higher up, and so on to the top of the shaft. This arrangement was further improved by connecting the delivery of the sump pump to the suction of the first lodgment pump, and the delivery of the first lodgment pump to the suction of the second lodgment pump, and so on. This tandem arrangement demanded that each of the connected pumps should be of the same size and have the same efficiency when running at the same number of revolutions in a given time. The next improvement it is believed was made by a Californian; at least, the first to advertise multistage centrifugal pumps in this country was a California manufacturer. In the advertisement was shown a series of centrifugal pumps on one shaft, arranged so that the pressure head of the first pump produced was delivered to the second pump, and this head augmented by the pressure head of the second pump was delivered to the third pump of the series and so on.

Fig. 1. Impeller and Diffusion Ring

Pumps arranged in this manner permit of several variations in head and capacity; besides the number of stages may be increased by additional pumps to the series, provided all have the same efficiency at the same speed. As an illustration, suppose that if three pumps, each capable of delivering 1,000 gallons of water per minute to a height of 100 feet, are run in parallel they will deliver 3,000 gallons per minute to a height of 100 feet, and if run in series will deliver 1,000 gallons per minute to a height of 300 feet.

When a number of centrifugal pumps having the same efficiency are arranged on a single shaft in series, so as to form a multistage pump, the efficiency is the same as when acting individually, but if one pump is less efficient than another the overall efficiency of all the pumps is not the product of the efficiencies of all the pumps but is the efficiency of the least efficient pump.

At the Avondale mine, near Plymouth, Pa., two six-stage centrifugal pumps were arranged tandem and successfully forced water from the mine up a slope 4,000 feet long.

In multistage pumps, the most important parts are the impeller or runner, and the casing; in fact, both have a great bearing on the efficiency of the pump. The impeller *a*, Fig. 1, which rotates on the shaft of the machine, consists virtually of two disks with curved blades between them. The blades and disks are usually cast in one solid piece, after which they are carefully smoothed by machine and then by hand, making use of a templet in the

latter instance in order that no rough spots may interfere with the passage of water. The water enters the impeller *C*, shown in section Fig. 2, at its center *B*, and as it equal to or greater than the head due to the depth of the mine. To lessen the velocity head and convert it into pressure head the impeller blades are curved backwards as pressure, by $\frac{f}{w}$. (3) The head due to the height above water level datum in feet has the symbol h. The sum of the three heads or total

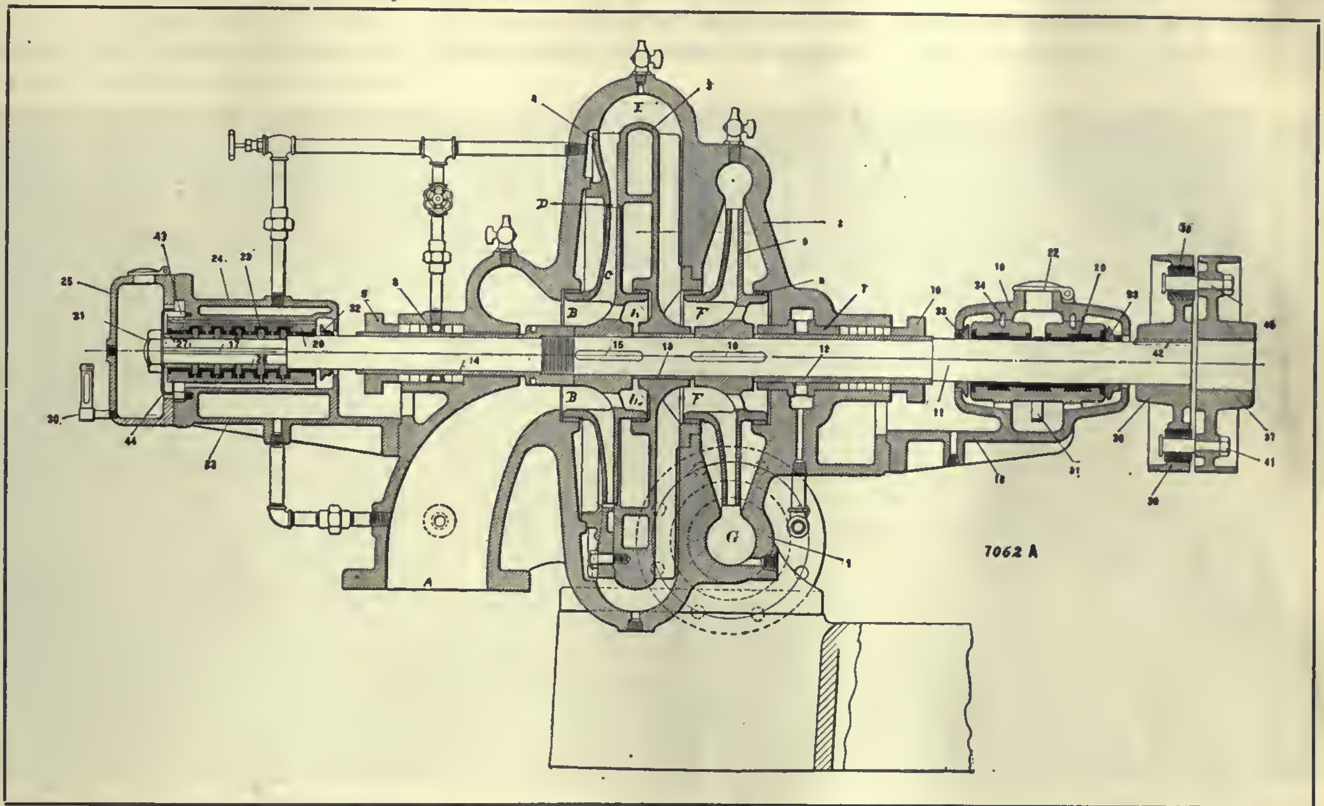

Fig. 2. Section Through Two-Stage Centrifugal Pump

assumes the speed of the rapidly revolving impeller it moves toward the periphery, where it is discharged with considerable velocity. Unless suitable arrangements are made to receive this water, the velocity will form eddies and create friction that will consume a large part of the power without producing useful work. The problem at this stage is resolved into the conversion of the velocity into pressure in order to force the water to some definite height, for it is possible to rotate the impeller very fast without raising the water above a certain height. In explanation of this phenomenon it is to be understood that when the water leaves the impeller it possesses its maximum mechanical energy in the form of "velocity head" or "kinetic energy"; but no water will flow up the delivery pipe unless the velocity is converted into static or pressure head.

shown in Fig. 1, and the casing is made with a gradual expansion to conform with Bernoulli's theorem based on the three heads which govern the energy of water flowing through pipes: (1) The head due to velocity is represented by the formula $\frac{v^2}{2g}$. (2) The head due to

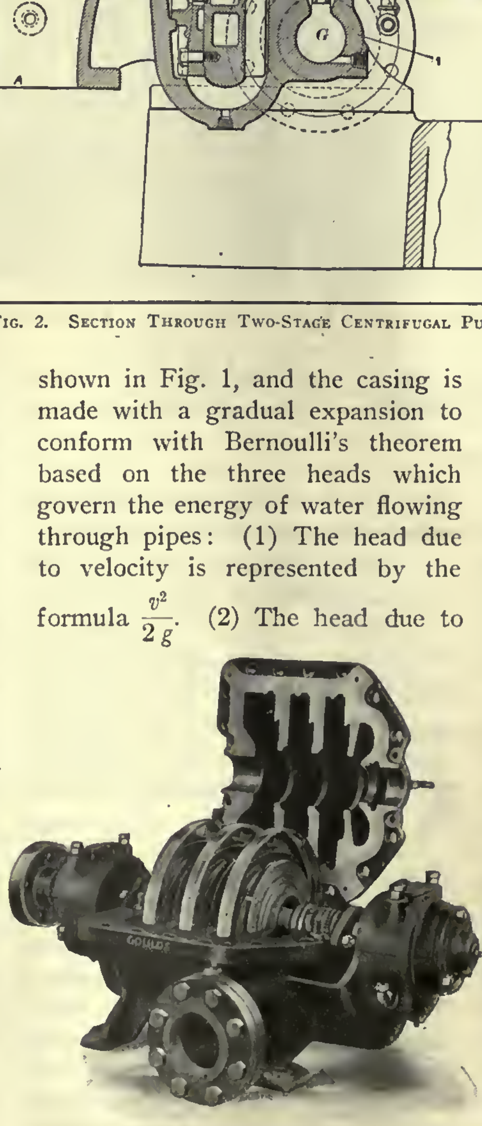

Fig. 3

head $= \frac{v^2}{2g} + \frac{f}{w} + h$. In this equation v = velocity in feet per second which is necessary to balance gravity; f = pressure in pounds per square foot due to the weight of the water; and w = weight of 1 cubic foot of water.

If friction is neglected, the principle of Bernoulli's theorem is that "when a constant quantity of water is flowing through a tube in a given time, the velocity varying at different points on account of changes in the diameter, the energy remains constant, and the sum of the three heads is constant, the pressure head increasing as the velocity decreases and vice versa."

In other words, if a stream of water flows through a pipe of gradually increasing cross-section, the initial velocity head which disappears because of the gradually slowing water reappears as a pres-

sure head. To apply Bernoulli's theorem to a centrifugal pump the diffusion ring *b*, Fig. 1, and *4*, Fig. 2, has been introduced in the pump casing so as to surround the circumference of the impeller. The passages in the diffusion ring are termed diffusion vanes, and these open into the volute casing or whirlpool chamber that forms the water passage *E*, Fig. 2, to the next pump impeller *F*, of the series. The tips of the diffusion vanes have sharp points, where the water enters, to prevent friction; and it will be noticed in Fig. 1 that the passages are comparatively long and tangent to the periphery of the impeller blades, also that they expand gradually to lessen the velocity of the moving water. Fig. 2 is a longitudinal section of a two-stage Cameron pump, in which *A* is the suction pipe, leading to the impeller openings *B*. The water passages *C* between the blades are gradually constricted to *D*, the circumference of the impeller, where the water discharges into the diffusion vanes *4*.

The water which enters the diffusion vanes at high velocity, has its velocity gradually reduced by the expansion and converted into pressure head when it enters the whirlpool chamber *E*, Fig. 2. The water now moves at the reduced velocity through the whirlpool chamber and with the pressure gained in the first stage enters the second impeller at *F*. After flowing through the second impeller it has the energy derived from the first impeller and the velocity of the second impeller and this latter velocity is reduced and converted into pressure head by passing direct into the whirlpool chamber *G* which is constructed in the form of a volute.

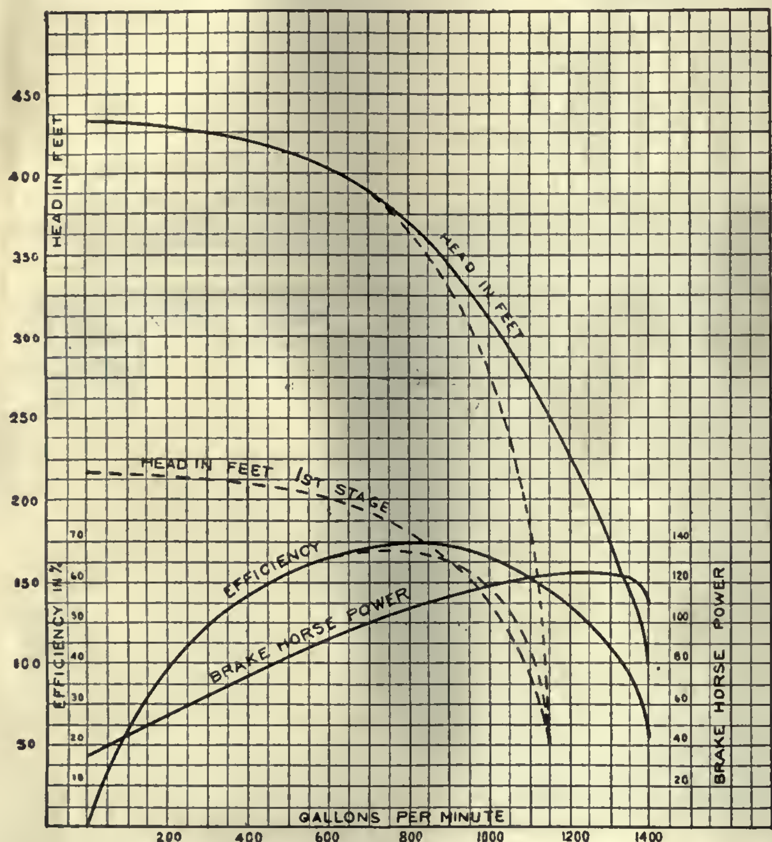

Fig. 4

The three-stage pump, Fig. 3, shows the position of the impeller and diffusion ring adopted by the Goulds Mfg. Co. The principal feature of this pump is the lateral discharge through the guide vanes from one stage to the next, instead of through whirlpool chambers and bends. The design allows of a much smaller casing than where the pump is fitted with a whirlpool chamber. The cut also shows the casing that the Goulds Mfg. Co. has adopted to make the working and wearing parts accessible, so that worn out parts may be replaced readily.

The diffusion vanes are omitted from the last stage of the Cameron multistage pump in order to increase the pressure, capacity, and efficiency of the pump, and at the same time simplify the construction. The effect of this omission in the last stage is graphically shown in Fig. 4, where the full lines represent the behavior of the pump, while the dotted lines show the characteristic curves of a pump having diffusion vanes at all stages. The question may arise from a study of this "graph:" Why not add or omit diffusion vanes in all stages? The answer is that some makers do, but it must be remembered that in all stages but the last the conditions to be met are radically different, owing to the sharp curve in the path of the water on its way from one impeller to the next. One maker claims that with diffusion vanes a pump can only be adapted to a certain number of revolutions per minute; another maker claims that "no multistage centrifugal pump can be constructed without this feature and give permanently satisfactory efficiency"; and yet makers using the different features produce efficient pumps. In the last stage, however, the water flows almost directly to the discharge pipe, and the volute chamber, if constructed properly, adjusts the velocity to meet a smooth delivery without shock.

With the first multistage centrifugal pumps, trouble was experienced from end thrust due to water entering on one side of the pump. This was overcome in a great measure by making use of the marine thrust bearing *27* in Fig. 2, so called because used on boats to take care of the thrust of the propeller. The marine bearing has usually a number of collars machined on the shaft which revolve in slotted boxes. No trouble was experienced with these thrust boxes

so long as they were kept properly lubricated, but in case of extreme carelessness on the part of the pumpman a hot box might occur. To minimize this chance and to make a bearing which could be readily changed without substituting a new shaft, the Cameron centrifugal pump is supplied with bushings constructed on the marine order, but differing in that collars *29* are not cut in the shaft but surround it as a separate piece machined to fit closely to the reduced shaft and rotate in the marine bushings *26*. By this arrangement in case of wear the collars and bushings may be renewed without delay. The balancing of the thrust has been accomplished also by making holes in the impeller web so that they would communicate with a balancing chamber *b* and connect it with the suction chamber *A*. The holes insure that the static pressure existing in the suction chamber shall be transmitted to the balancing chamber.

Mine water is wearing on any kind of pump, because it holds grit in suspension and usually contains acid, or an acid salt, in solution, which reacts on the metal pump lining.

The peripheral speed of a 12-inch diameter impeller when turning about a shaft at the rate of 570 revolutions per minute is 1,790 feet, and will require 128 horsepower to raise 5,100 gallons of water per minute to a height of 70 feet. This is at the rate of $\frac{1}{3}$ mile per minute; and grit traveling at this speed obtains sufficient energy to wear away impeller blades and also diffusion vanes. To diminish the corrosive action of water and to lessen the wear on the impeller blades and diffusion vanes, a special hard bronze is used for these parts, probably a little different from the alloy used to line reciprocating steam pumps. Wherever possible it is thought economical to use a steam turbine to drive centrifugal pumps, but as a rule pumps of this description in underground mine work are driven by electricity.

Two methods of testing centrifugal pumps were described under the article preceding this and entitled "Single-Stage Centrifugal Pumps." However, the method following is added to complete the tests adopted by up-to-date pump manufacturers.

One of the most modern methods for rigid and exacting tests of centrifugal pumps is by means of a special torsion dynamometer, designed for measuring the power transmitted to the pumps.

Three weir tanks are provided, the smallest having sufficient capacity to test pumps up to 4-inch discharge, the next larger to test pumps up to 6-inch discharge, while the largest tank has a capacity for testing pumps delivering 16,000 gallons per minute. The larger weir tank in use by the Cameron Steam Pump Co. has an adjustable weir gate that makes it unnecessary to change weirs when different sized pumps are tested. This swinging weir gate consists of several hinged sections, which are swung into place as occasion requires. A view of the tanks, weir, and torsion dynamometer is shown in Fig. 5.

The torsion dynamometer is coupled to both the shaft of the driving motor and the pump, therefore, its shaft transmits the power from one machine to the other, and in consequence is subjected to torsion. This dynamometer shaft is designed to transmit a certain fixed range of horsepower, thereby preventing the stress due to

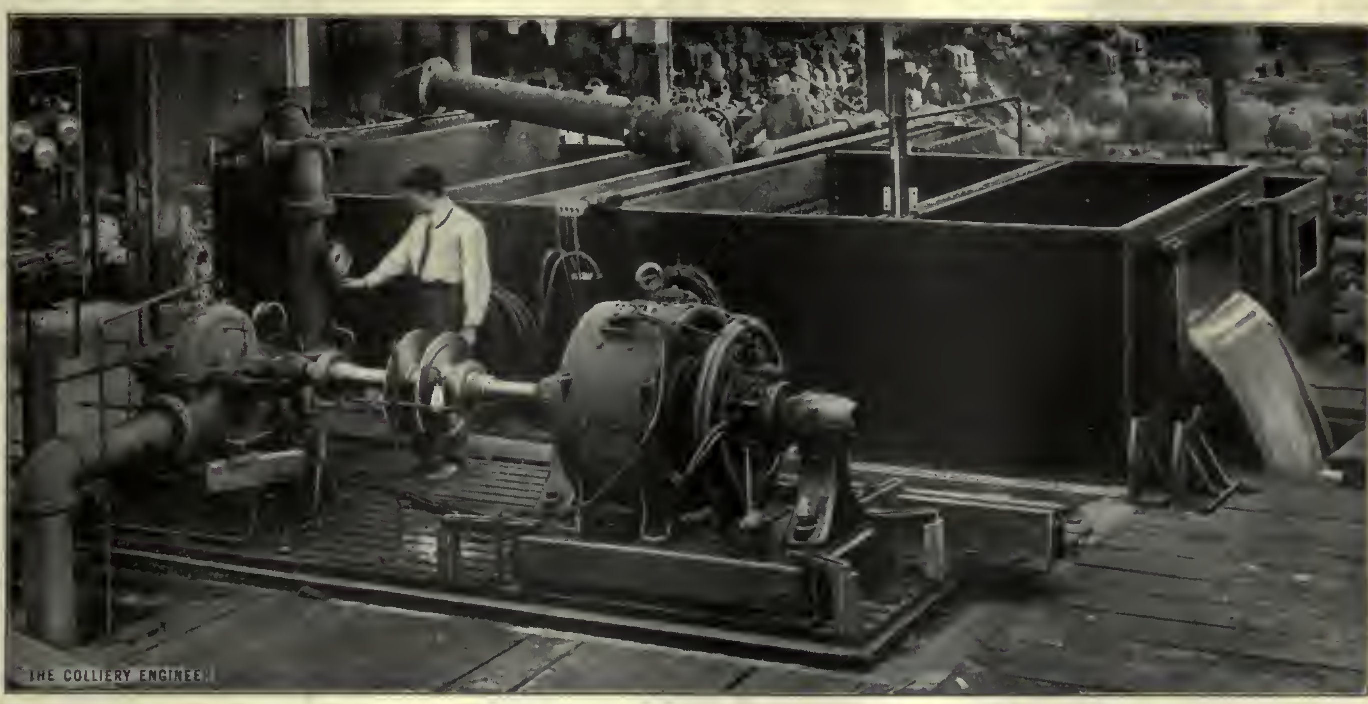

Fig. 5. Cameron Steam Pump Works Apparatus for Testing Pumps

the power transmitted, from exceeding the yield point in the material.

Since this shaft and the other parts connected to its extremities have no tendency to move, due to the centrifugal force, the readings of the dynamometer are independent of the speed. The instrument can therefore be run at any desired speed, provided no forces are set up greater than can be resisted by the material of which the disks are made.

The results obtained from the dynamometer are extremely accurate in determining the horsepower input to the pump, as its action is entirely independent of losses due to belt slippage, or possible unrecorded current losses through the motor, when the pump is undergoing a brake-horsepower test.

The data that follow will be found useful in connection with centrifugal pumps: 1 horsepower = 550 pounds raised 1 foot per second for 60 seconds or 33,000 foot-pounds.

The efficiency of a pump is found from the ratio

$$\frac{\text{Water horsepower}}{\text{Brake horsepower}} \text{ or } \frac{W\,H\,P}{B\,H\,P}$$

$$W\,H\,P = \frac{G\,P\,M \times h}{3{,}960}$$

$G\,P\,M$ = gallons per minute raised to a height h; 3,960 = 33,000 ÷ 8.3356 or 1 horsepower ÷ the weight of 1 pound of water in 1 U. S. gallon at 62° F.

$B\,H\,P$ of a direct-current motor = volts × amperes × 1.34 × motor efficiency.

$B\,H\,P$ of an alternating-current motor = volts × amperes × cos θ × K × 1.34 × motor efficiency.

One K. W. or electric horsepower $= 1{,}000 \text{ watts} = \frac{1{,}000}{746} = 1.34$ horsepower. $K = 1$, for single-phase motor; $K = 2$ for two-phase motor; $K = 1.732$ for three-phase motor; and cos θ = power factor of the motor.

The combined efficiency of pump (E. P.) and electric motor (E. M.) is in the ratio $\frac{W\,H\,P}{E\,H\,P}$, or is equal to the product of pump efficiency and motor efficiency.

To determine the cost of electric current for pumping any number of gallons of water per day, it is necessary to know the cost (c) of the current per kilowatt hour (K. W.) the efficiency of the motor ($E\,M$), mechanical energy of the pump, and the height to which the water is pumped, then cost

$$= 24 \times c \times \frac{G\,P\,M \times 8.3356 \times h}{1.34 \times E\,M \times E\,P \times 33{,}000}$$

Example.—What would be the cost of pumping 1,000 gallons, per minute, 1,000 feet high, assuming the motor efficiency to be 90 per cent.; the pump efficiency 72 per cent. and the cost of the current 1 cent per kilowatt hour. Ans. 56 cents per day.

For information and illustrations in these articles the writer is indebted to the Goulds Mfg. Co., Seneca Falls, N. Y., A. S. Cameron Steam Pump Works, New York City.

Why Do You Wet Coal on the Forge?

By Dr. Leonard Keene Hirshberg, A. B., M. A., M. D. (Johns Hopkins)

As a kind of extra fortification against the assault of the blast, the wetting of coal will save much loss. Not only is the moisture an aid to economy, but in the use of an indifferent fuel the wetness weights down the materials and keeps it from being blown off the hearth.

In order that the particles may hold together all the better, when being thrown into the furnace, the slack coal is dampened when firing the boilers. If this is not done, most of the slack fuel will fall at once through the fire-bars and thus be a loss and additional expense.

Dry coke is one of the best fuels to use for smith work. It shows great superiority over other fuels, if broken to about 1½-inch mesh. For this it is always advisable to have a fairly thick bank of wet slack on each side to retain the blast and to prevent the breast plate and the tuyere from being burned.

A handful of salt thrown into the fire will assist in clearing it of impurities. This is salient because such impurities interfere with welding as well as other important operations. Salt should be employed always to thoroughly clear the forge after any such uses as those made by the plumber. One of these, for example, is to bend galvanized pipe, another is to melt lead and solder. If these precautions are not taken, considerable trouble will follow for some time afterwards.

To maintain in the forge a live fire, especially in instances where the fires are kept going intermittently as in small jobbing machine shops, in shops where the employes mend, make, or temper their own tools, a piece of timber should be pushed into the center of the forge. This will be found to be decidedly more effective than if the blast were kept at half cock.

The timber should be placed in the water bosh when the forge is in use; this prevents it from burning away too quickly. A good plug-cock control of the blast is much to be preferred to the common slice or damper affair, usually fitted at the forge back. The force of the blast can be regulated in a way that is truly necessary if temperings are to be carried out satisfactorily. The plug of the cock should be removed occasionally and coated with tallow; this keeps it in good condition and prevents it from sticking and from getting too loose.

The damper control of the blast is generally such that a great deal of "wind" is wasted and it has the unhappy knack of automatically closing when both hands are fully employed and supreme blast is needed. The top tip of the tuyere burns away more rapidly than the bottom, consequently slag and clinker can run into the opening readily and choke the blast. The economical smith should turn his tuyere again and again as he sees this wastage of the top take place, and thus quadruple its life, and get better results all through. This burning away is due to the blacksmith commonly using an open fire and a dry tuyere.

Gas Producers

And Concentration of Power at Mines—Means of Obtaining Power from Low-Grade Coals as Cheaply as Steam Power from High-Grade Coals

*By R. H. Fernald**

THE reports of the United States Geological Survey show that the rate of high-grade fuel consumption is over 500,000,000 tons annually. This means that low-grade fuel, now generally considered as waste, should be utilized. There are many possibilities for producer-gas power plants in the utilization of:

1. Low-grade or high-ash fuels, which at present are regarded as practically worthless.
2. Extensive deposits of lignite found in various sections of the country.
3. Peat from vast areas of swamps and bogs.

The area occupied by the anthracite and bituminous coal fields is about 200,000 square miles, which is about the same as that occupied by the subbituminous coals and lignites hitherto regarded as non-commercial fuels. The interesting point is the fact that the areas occupied by bituminous coal, lignite, and peat do not overlap to any extent.

In studying the low-grade fuel problem, the relation between the heat losses in steam and gas plants is very important. Let us assume that 13,500 heat units are thrown into the furnace under our boiler; that is, a pound of coal representing 13,500 heat units. There are lost in the ashes about 135 units; in radiation from the boiler 675 units; carried away in the gases nearly 3,000 heat units; pipe radiation, leakage, etc., 620 heat units; rejected to the condenser nearly 8,000 heat units; making the total loss over 12,000. Thus, out of that 1 pound of coal containing 13,500 heat units, there is converted into power at the main shaft of the engine only about 1,300 heat units, about 9½ per cent. of the heat energy that was in this fuel, and that, furthermore, is an exceptionally efficient plant. The efficiency of the average steam plant of this country is less than 5 per cent.; that is, we are able to deliver to the bus bars only about 5 per cent. of the heat energy in the fuel that was thrown into the furnace. In the ordinary incandescent carbon light the return in the form of light is only about one-seventh of 1 per cent. of the heat energy that was in the coal which was put into the furnace to develop that light. In one of the most efficient steam plants in the United States they are able to convert into energy at the bus bars only a little over 10 per cent. of the energy that was in the fuel thrown into the furnace. The losses for the plants are about 95.3 per cent. for the steam plant and 81.3 per cent. for the gas plants, or the net efficiency about 4.7 per cent. in the steam plant, which is about right for the average steam plant of the country; and about 18.7 per cent. for the gas plant, which is high for the average gas plant, although there are gas plants that are giving better efficiencies than that.

In one of the most efficient steam plants in the United States, that of the Interboro Rapid Transit Co., in New York, Fifty-ninth Street station, in order to develop 100 heat units at the bus bar, 970 heat units must be thrown into the furnace in the form of fuel. With grades of fuel ranging between 14,000 and 15,000 heat units per pound, the average gas plant requires a little over 1 pound per horsepower; the steam plant 3 pounds.

For a study of the relation between the steam and the gas plants, a certain standard should be adopted. Take one of the highest grade West Virginia coals as the basis—West Virginia run-of-mine coal with only 2.4 per cent. ash and 7 per cent. moisture. In the average steam plant are used 2.9 pounds of this high-grade West Virginia coal per horsepower hour. Using this same coal in the gas plant required .87 pound per horsepower hour as against 2.9 pounds of the same fuel in the steam plant. Taking the coals containing 20 per cent. or more ash, the following is developed: With New Mexico run-of-mine coal containing 20.6 per cent. ash, the gas plant requires only 1.1 pounds, including the ash, per horsepower hour—only a little more than was required of the high-grade West Virginia coal.

Lignite is the intermediate stage between peat and coal. It contains from 20 to 40 per cent. moisture and if allowed to stand out in the weather it soon disintegrates.

Using the same standard as before, the West Virginia coal, the steam plant required 2.9 pounds per horsepower hour. With lignite from North Dakota, containing about 40 per cent. moisture, the gas plant required just about the same amount of lignite per horsepower that the steam plant required of the high-grade coal. In other words, the general statement holds that the North Dakota lignites are as efficient in the gas plant as the highest grade of West Virginia coal in the steam plant. A number of producer gas plants in Texas, having from 15 to 4,000 or more horsepower, are running on lignite.

Lignites containing from 20 to 40 per cent. moisture cannot be readily shipped on account of the excessive freight. This results in a demand for lignite briquets which would contain but a small percentage of moisture. Lignite corresponds very closely to the brown coal of Germany. Lignite can be briquetted without using a binder. The Bureau of Mines has made lignite briquets, although some difficulty has been experienced in perfecting a commercial briquet that will stand transportation and weathering.

The next grade of fuel to be mentioned is peat. To produce peat at the beginning of April, necessitates

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clearing and draining the bog in November. In the average bog the peat is from 6 to 10 feet in depth.

Commercially dry peat contains about 25 to 30 per cent. moisture. Peat in Sweden on the producer floor costs about 80 cents a ton as against about $3.80 for coal imported from England. It takes on an average about 2 pounds of peat to be the equivalent of 1 pound of good coal. That makes the relative cost in Sweden about $1.60 compared with $3.80 for coal.

Russia has probably done more in the line of production of peat for fuel purposes than any other country. Russia was mining in 1908 over 5,000,000 tons of peat for power purposes.

In using Florida peat containing 21 per cent. moisture, it was found that 2.4 pounds were required per horsepower hour. In 1912 there were 610 gas producer plants in the United States using anthracite, 77 operating on bituminous coal, 32 on lignite, and one on wood.

In 1912 the anthracite plants represented in horsepower 47.8 per cent. of all the producer plants in this country. They are small in size but large in number. One plant in Arizona developing 4,000 horsepower is operating on anthracite. The coal costs $11.30 a ton but it is cheaper than using bituminous coal.

One of the greatest drawbacks to the use of low-grade fuels and the concentration of power at the mines has been the fact that producer-gas plants have been so small. It has been shown conclusively that it is quite possible to use poor grades of fuel, but it would not pay to go to the mines to put up central plants unless the units are of good size. Plants at the mines should probably range from 50,000 to 250,000 horsepower for any given installation. The latest gas producer is built up much like a sectional bookcase. It is made up of sections of sheet steel and channels and all that is necessary for enlarging the producer is to take off the end and put in another section. Producers of 10,000 horsepower in a single shell could undoubtedly be constructed in this way. A 3,000 to 4,000 horsepower producer occupies space about 12 ft. × 25 ft. The ash beds are sectionalized; the air is supplied to each section of the ash bed so that clinker troubles, channeling or other operating difficulties can be controlled.

The other part of the subject, the question of centralization of power at the mine, hinges largely on large units. The first plant to be erected at the mine, or the base of fuel supply, was a little plant of 300 horsepower in Sweden, which is located right in the center of a peat bog. A large central plant in England, which is not directly at the mine, is the South Staffordshire Co.'s plant. This plant (which is a by-product plant) is a 20,000-horsepower installation, and at the present time is being increased to 36,000 horsepower. The gas is sent through some 37 miles of 3-foot pipe, which distributes it over large industrial areas. The gas sells at an equivalent of 14 cents a thousand for ordinary city gas. Gas for which one pays 75 cents to $1 in this country is sold for 14 cents; that is, the charge is from 3 to 5 cents a thousand for gas of 150 British thermal units value.

Sulphate of ammonia is an excellent fertilizer, and sells at from $50 to $60 a ton. From each ton of coal burned about 90 pounds of sulphate of ammonia can be recovered. Plants of this type will undoubtedly be established in this country within a short time. Both German interests and English interests have been looking into the proposition in the United States. One or two of the large coal companies have been investigating this proposition with a view to establishing by-product plants at the mine, and one of the English companies has been studying the peat proposition in Florida for this particular purpose.

In Pennsylvania there is a mine burning underground that has been generating producer gas for 10 years. Another mine fire in Pennsylvania that has been burning since the year 1859, has already consumed 26,000,000 tons of coal, generating producer gas under ground. The company has spent, up to the year 1908, a million dollars trying to stop that fire, but without success. In 1908 they put in a non-combustible fire wall as the only means of stopping the fire, but this was unsuccessful.

Practically every fuel tested by the government in the gas producers, including coals containing as much as 44 per cent. ash, and lignites and peats high in moisture, was successfully converted into producer gas which operated gas engines. The use of these low-grade fuels which have previously been regarded as of little or no value, increases the country's resources approximately 150 per cent. It has already been shown that on an average there was developed from each coal tested in the gas-producer plant, two and one-half times the power developed when used in the ordinary steam boiler plant, and such relative efficiencies will probably hold good for the average plant of moderate power capacity, though this ratio may be reduced in large modern steam plants. Lignite beds underlying from 20,000,000 to 30,000,000 acres of public lands, supposed to have little or no commercial value, have been shown through these investigations to have a large value for power development, and the money value of the government's own property has been increased to the extent of probably $300,000,000 or more.

An important factor developed in these investigations is that the general use of gas producers for the development of power means the practical elimination of the smoke nuisance. This is important in those cities forced to use bituminous coal. At the present time several factors are working together to bring about a natural reduction in the amount of smoke discharged into the atmosphere. Among these are: (1) The elimination of numerous small inefficient, poorly manipulated, individual house heating plants by the introduction of district

or central heating stations. (2) The increasing use of electric power in factories and office buildings and for miscellaneous purposes, resulting in the reduction of the number of small steam-power plants. (3) The economic advantages of producer-gas plants bringing about the rapid introduction of these installations. (4) The centralization of large producer-gas installations at the mines with the distribution of the energy over extensive areas either in the form of electric current or as gas.

In considering mine refuse, lignite, and peat, it is seen that their transportation long distances is practically prohibited. The high ash content in the mine refuse and the high percentages of moisture in lignite and peat necessarily make the cost of transportation per ton of pure fuel too high to compete with water-power. The Bureau of Mines is, at the present time, trying to eliminate the inconvenience and excessive expense involved in handling high percentages of non-combustible material.

Central stations for power and lighting are springing up all over the country. Electric lights are now in general use in towns numbering their population by hundreds only. Electric transmission for street railway service is practically universal and electric power for shop drive is in great demand. The substitution of the electric locomotive for the steam locomotive for terminal service, and even for line duty, by several leading railway systems, is no longer a mere expectation, but is an every-day working reality.

Consideration of these conditions in order to keep the price of power developed from fuel down to a consistent figure indicates:

1. Grades of fuel which warrant transportation or which may be defined as marketable should be used with the greatest possible practical economy.

2. The very large percentage of coal of so-called low grade which is today left at or in the mines must be utilized.

3. Advantage must be taken of the large deposits of lignite and peat which are found in many sections of the country.

4. These conditions can be splendidly met by the use of the producer-gas plant for industrial purposes which do not require the use of steam for other than power developed.

Compass Surveying

By Richard Bowen

In my opinion every mine official should be thoroughly familiar with the surveyor's compass so as to be able to use it for the various purposes for which it is made. Where the compass has not been used the fact is at once apparent upon examination of the mine map. The map makes it equally plain that the work could have been done much better had the headings and chambers been driven on established lines. It now is so done in every mine in charge of competent officials. Probably the simplest operation for which the compass is used is in the location of two points to serve as guides in driving an opening in a particular direction. Local conditions make it necessary to vary the usual method to suit special cases.

When the heading shown in Fig. 1 was driven and reached station 101 it was found necessary to change its direction. Stations 100, 101, and 102 were put in by the regular surveyor with the transit, which makes the bearing of their connecting lines known.

The mine foreman having examined this section of the mine, decides upon the proper angle which the center lines of the chambers must make with the line of dip of the seam. He then takes a tracing of the entry, which is made for his use by the mine surveyor, on which the north and south lines (meridian) is marked, and draws the center lines of the chambers in the direction decided upon, and as far apart as the nature of the seam requires. Having been told by the surveyor that the direction of the line from station 100 to station 101 is S 67° 20′ E and having found with the aid of a protractor that the center lines he has drawn on the tracing run N 62° E, he is prepared to put in points for the center lines. Arriving at station 100 he sets the compass directly under it (the stations are supposed to be in the roof), levels it, unclamps the needle and sights to station 101. Upon reading the needle after it has settled he finds that it indicates a bearing of S 67° 15′ E, which is practically the same as the bearing found by the transit survey, and shows that no local attraction is influencing the needle. A chamber being desired opposite station 100, the compass plate is turned until the north end of the needle points to N 62° E. An assistant is then directed to hold his light against the roof in line with the compass sights through which the foreman is looking and guiding the position of the light; the point in line having been found and marked with a piece of chalk carried for the purpose, a hole about three-eighths of an inch in diameter is drilled in the roof and a wooden plug is inserted. An ordinary screw eye is next to be driven in the plug, and to do this a light is held back of the screw eye so it can be seen through the compass sights. The screw eye is moved as the foreman looking through the sights may direct until it coincides with the vertical hair in the sight; then it is driven into the plug. As this point is necessarily close to station 100, it may be advisable to locate another point in the lower (right hand) side of the heading, as more accurate results are obtained when the sight points are further apart; besides, it will then be unnecessary for the miner to make use of station 100, for in doing so he may injure or destroy it. This second point being in a direction exactly opposite the first one, requires the compass to be turned through 180 degrees or a half circle, when its needle will read S 62° W. When the compass is in this position the point is put in the roof exactly as was the first point.

Let us take another case where the needle is influenced by local attraction. Suppose that the compass when set up at station 100 and sighted to station 101 had a needle reading of S 58° 42′ E instead of S 67° 20′ E, the proper bearing. Evidently it would not be right to turn the compass until the needle gives a reading of N 62° E, for that

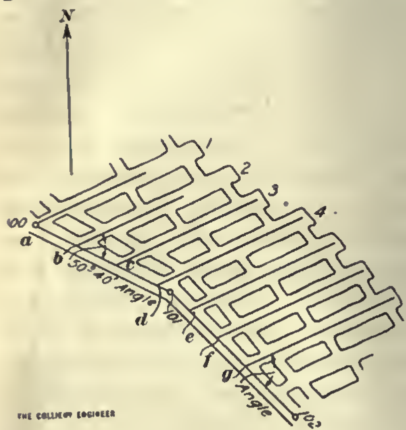


Fig. 1

would necessitate its being turned through a greater angle than in the previous case, and certainly both cannot be correct. The reading S 58° 45′ E is 8° 35′ to the right of the true reading, since 67° 20′ − 58° 45′ = 8° 35′, and this correction must be made to the bearing of the center line of the chamber. A line passing 8° 35′ to the right of one running N 62° E will have a bearing of 62° + 8° 35′ = N 70° 30′ E, which is near enough, and the sight points can be put in.

The local attraction influencing the needle may deflect it in the opposite direction; that is, the bearing from station 100 to station 101 as shown by the compass needle might be S 73° 30′ E. In this case there is a difference of 6° 10′ between the true and observed bearing, since 73° 30′ − 67° 20′ = 60° 10′ the needle being deflected to the left that amount. Correcting the bearing of the center line of the chamber by 6° 10′ to the left, makes it N 55° 50′ E, since 62° − 6° 10′ = 55° 10′.

Other chambers are to be started from this heading, the center lines to be parallel. For this purpose, the compass is set under station 100 and sighted to station 101, no notice whatever being taken of the needle reading. It is necessary to calculate the distance that must be laid off on the heading between the center lines, for it will be noticed that this distance is not the same as that measured at right angles to the center lines. The distance measured on the heading between the center lines, is

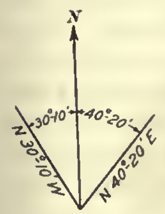


Fig. 2

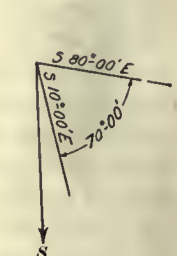


Fig. 3

found by dividing the sum of the width of the chamber and the width of the pillar, by the sine of the angle included between the center line of the chamber and center line of the heading. The angle is found by adding the two bearings together and subtracting their sum from 180° thus (67° 20′ + 62°) = 129° 20′ and 180° − 129° 20′ = 50° 40′. Now suppose that the width of the chamber is 25 feet and the width of the pillar is 20 feet then the distance measured between the center lines on the heading equals $\frac{45}{\sin 50°40'} = \frac{45}{.773} = 58.2$ feet.

Assume another case, Fig. 2, where chamber and heading are on opposite sides of the meridian. For example, suppose that the chamber bearing is N 40° 20′ E, and the heading bearing is N 30° 10′ W, then the angle is found by adding both bearings together; thus, 40° 20′ + 30° 10′ = 70° 30′, and the distance measured between the center lines on the heading will be $\frac{45}{\sin\ 70°30'} = \frac{45}{.942} = 47.7'$ Again, assume that the chamber and heading are in the same quadrant; that the chamber has a bearing of S 80° E, Fig. 3, and the heading has a bearing of S 10° E, then the angle is found by taking the difference between the two readings, or 80° − 10° = 70°. The distance between the center lines on the heading is found as before.

To put up lines for chambers 2, 3, and 4, set up the compass under station 100, sight it to station 101, and clamp it. Next put up a screw eye every 58 feet and in line with the uprights or compass sights; the second spad of each line will be put in as described.

It must not be taken for granted, however, that there will be nothing at these points to deflect the needle because no attraction existed at station 100. As the compass is set up at each one of these points the precaution must be taken to backsight to station 100 or foresight to station 101, when the needle reading should be N 67° 20′ E or S 67° 20′ W, respectively.

At station 101 the heading changes its direction, the bearing to station 102 being S 50° E. On this line of sight the points *d*, *e*, *f*, and *g*, are located, from which sight points are to be put in; but *d e f* and *g* will not be the same distance apart that *a b c* are, because of the change in direction of the heading. This change in direction, however, does not change the compass; that is, if the compass set at *d* for example, and sighted to station 102 gives a needle reading of S 50° E, it must, as before explained, be turned until the needle reads N 62° E, in order to properly put in the sight points, in case the needle is deflected from its proper position. At any one of the points *d*, *e*, *f*, or *g* the correction is exactly the same in kind and application as previously explained.

Lord Dundonald obtained a patent for coking coal in retorts. He obtained volatile products which he condensed in a chamber covered with lead plates over which water was kept constantly running. In this way he obtained tar which formed an excellent varnish for ships. This occurred about 1786.

Use of Concrete Underground

Methods in Use in Some Shafts in the Copper Country—Competitive Tests of Wood and Concrete of Varying Compositions

*By H. T. Mercer**

THE rapid growth in favor of concrete for certain classes of construction has been one of the most noteworthy engineering developments of late years; and in this the applications made to the mining field have played an important part. This is owing to the decreasing supply of suitable timber and to the limited life of even the best timber when exposed to underground conditions.

Concrete has been used for many years in building underground dams, bulkheads, etc., but the principal uses of concrete in mines is in connection with shaft supports, and it is the purpose of this paper to describe some of the work that has been done along these lines in the Copper country. Good examples of concrete shaft collars can be seen at many of the mines, and although the details vary somewhat, a description of one or two will perhaps suffice to illustrate this form of construction.

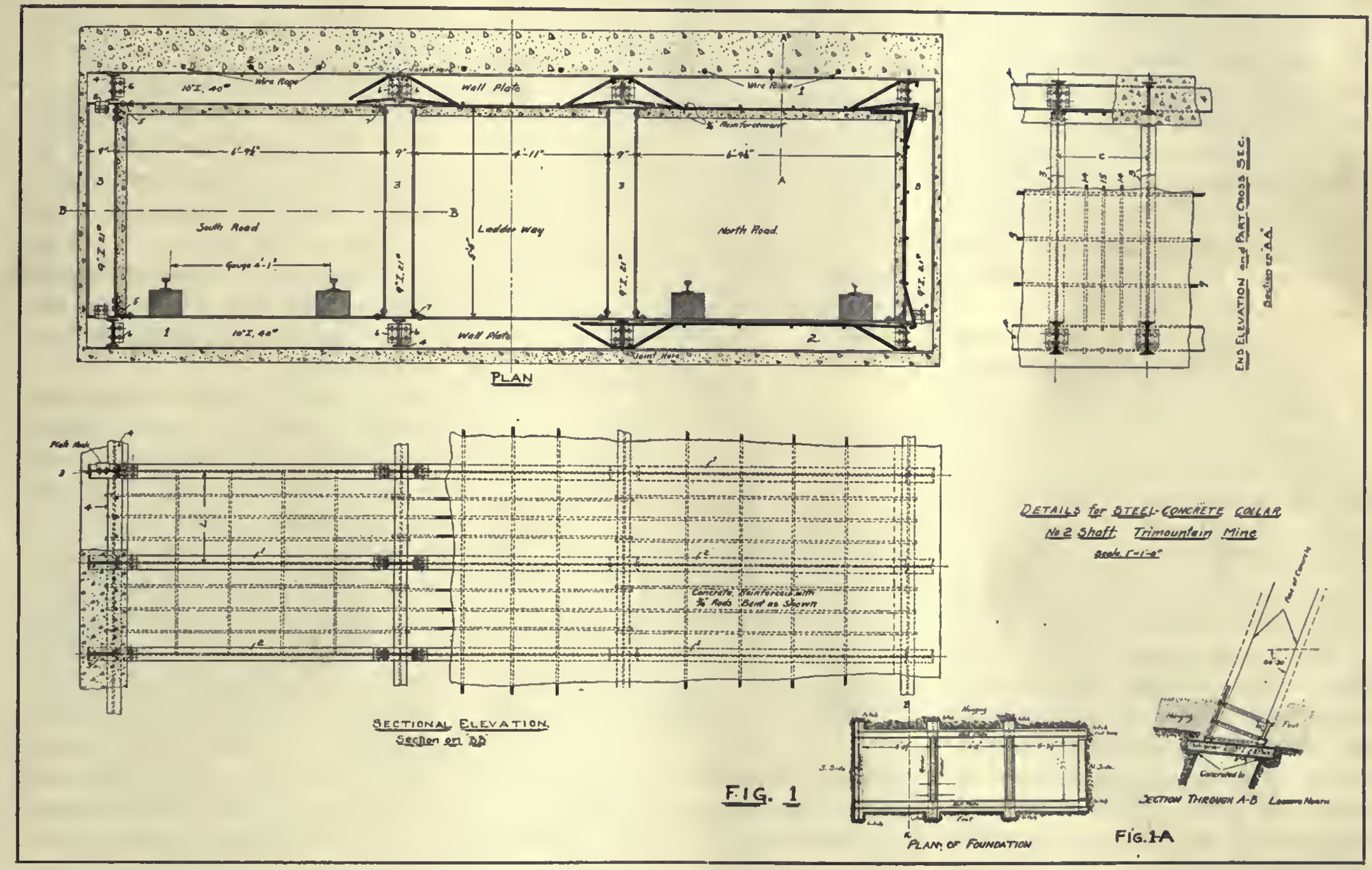


FIG. 1 FIG. 1A

At the Trimountain mine it was decided to replace the old timber collars with concrete, and work was begun at No. 2 shaft, where the overburden was 80 feet deep, consisting for the most part of sand, with more or less clay and some boulders. To guard against any possible "running" of the sand, and to make the operation of the shaft during construction easier, as well as to reinforce the concrete, it was decided to replace the timber with steel I-beam sets, and then concrete between and around the steel sets. The sets would provide a support in case it became necessary to put in lagging to hold back the sand before the concrete was placed. A foundation was first prepared at the ledge by placing heavy steel I-beam box girders across the shaft from foot to hanging under the dividers and under the south end plate (Fig. 1A). At the north end there was a natural rock ledge or shelf. Starting from the foundation thus formed the steel sets were built upwards two or three at a time, and concreted in. The work proceeded as follows:

First, the old timber on the ends and foot-wall was taken out for as great a distance as was deemed safe; then two or three of the steel sets were bolted in place; after which the forms were erected, and the concrete poured. Then another space would be opened and the operation repeated, and so on until the surface was reached. Fortunately the old hanging wall plates did not have to be removed, as there was sufficient clearance to permit the new concrete lining being carried inside of them.

* Paper read at Houghton meeting of the Lake Superior Mining Institute, August, 1912.

Care was taken to leave no timber or blocking under the foot-wall side of the concrete lining which might by rotting permit settling. The sand was carefuly tamped along the foot-wall as the concrete was finished. One skip road and the ladderway were built first, hoisting going on meanwhile in the other compartment. The skip was then changed over to the completed road, and the other road was built up. The steel sets were 2 feet 4 inches apart in the lower half of the collar, and 3 feet apart in the upper half, center to center. The concrete between the sets was reinforced with ¾-inch rods, as shown by Fig. 1, which also shows the construction of the steel sets and the position of the concrete.

The materials used for the concrete were: Portland cement, coarse amygdaloid stamp sand, and crushed trap rock. They were mixed by hand in the proportion 1:3:5, in the shaft house just back of the shaft and lowered by means of a bucket and trolley, the trolley rope being concreted in on the hanging side as the work progressed. As no difficulty was experienced at No. 2 shaft with the sand running in, or otherwise, it was decided to build the Nos. 3 and 4 collars of reinforced concrete only, leaving out the steel sets. Fig. 3 shows the construction of the No. 3 collar, which was started in June, 1910, and finished in August, 1910. The materials for the concrete were the same and the work was carried on in the same manner as at No. 2 except that there were no steel sets. The collar at No. 4 shaft was similar to the one at No. 3, except that the dividers were made 12 in. × 48 in. instead of 12 in. × 12 in. The overburden at No. 4 shaft was 128 feet deep on the pitch of the shaft (71 degrees), that at Nos. 3 and 2 being 60 and 80 feet, respectively; but in order to secure a suitable foundation, the No. 3 and No. 4 collars were started some distance below the ledge in the solid rock. The length of No. 3 collar was 93 feet, and of No. 4 was 158 feet.

Comparative Statement of Cost of Concrete Shaft Collars

Labor	No. 2 Shaft	No. 3 Shaft	No. 4 Shaft
Length, to foundation	80 feet	93 feet	158 feet
Shaftmen	$2,019.10	$1,028.85	$1,994.70
Masons	528.51		
Surface labor	301.80	295.50	192.45
Blacksmith labor	360.41	67.55	40.50
Machinist labor	311.76	41.82	27.85
Carpenter labor	144.97	42.73	54.69
Electrician labor	10.84	8.82	8.96
Teaming labor	120.56	74.46	56.64
	$3,797.95	$1,559.73	$2,375.79
Supplies			
Structural steel	$2,180.56		$ 136.00
Cement, 1,252 sacks, No. 2	588.83		
Cement, 1,238 sacks, No. 3		$ 470.80	
Cement, 2,169 sacks, No. 4			810.09
Stamp sand, 11 cars, No. 2	159.50		
Stamp sand, 3½ cars, No. 3		45.70	
Stamp sand, 8½ cars, No. 4			123.25
Fine rock, 6 cars	90.00		
Sundry supplies	261.75	102.55	75.91
Freight	215.33		
	$3,495.97	$ 619.05	$1,145.25
Total cost of shaft collars	$7,293.92	$2,178.78	$3,521.04

No. 2 shaft collar commenced February, 1907, completed August, 1907.

No. 3 shaft collar commenced June, 1910, completed August, 1910.

No. 4 shaft collar commenced March, 1911, completed August, 1911.

Cost Per Foot	Labor	Supplies	Total
No. 2 shaft	$47.47	$43.70	$91.17
No. 3 shaft	16.77	16.66	23.43
No. 4 shaft	15.04	7.25	22.29

Fig. 2 illustrates a reinforced concrete collar designed by Mr. W. F. Hartman for No. 6 shaft, Mohawk mine, where the dip is about 38 degrees. The reinforcement was rods and wire rope. The collar was built in 17 days and the total cost was $3,931. The length of the collar was 100 feet. A pit was first excavated at the shaft site. Then the forms were started at the bottom and built up as the work progressed. The concrete was mixed on the surface and run down to the working platform in an iron trough. The use of concrete for station floors, levelers, stringers, and dividers is becoming quite common.

Fig. 4 shows a station in one of the Champion Copper Co.'s shafts, and indicates the manner in which the levelers are reinforced; also the method used for concrete stringers. At first an all-concrete stringer was built like the one at the Ahmeek mine, designed by Mr. W. J. Uren, to which the rail was bolted by means of bolts and clips as shown in Fig. 5; but because of the hard rigid roadbed thus formed and the consequent wear and tear on the skip and rails, and the working loose of the bolts and clips the scheme was abandoned in favor of a combination wood and concrete stringer.

Fig. 4 shows the method in use at the Copper Range Consolidated Co.'s mines, and the Mohawk and Wolverine scheme is illustrated in Fig. 6. Both methods made a very satisfactory roadbed.

At some of the mines where the foot is subject to "heaving," concrete stringers cannot be used advantageously.

In sinking through some loose ground at one of the Champion shafts it became necessary to close timber, or line the shaft. Concrete 12 to 18 inches thick was put in, reinforced with old rails and wire rope. The concrete extended across the hanging and down on both ends, and sometimes across the foot, and there were also heavy concrete dividers 4 feet high by 10 inches thick, placed 10 or 12 feet apart. At several levels the whole plant was arched over with reinforced concrete. This lining has been in place about 2 years and has proven satisfactory.

Drift sets built of concrete have been tried to some extent at the Wolverine and Mohawk mines in some of their cross-cuts where loose ground was encountered. These sets consisted of legs 6 in. × 6 in. in section, and a cap 6 in. × 8 in., reinforced with ½-inch rods and wire rope. Concrete planks, reinforced with Kahn expanded metal, or woven wire, were used for lagging. Above the caps they were 4 in. × 14 in. in section and behind the legs 2½ in. × 14 in.

The use of reinforced concrete in the form of shaft sets and lagging is well described in a paper read before the Michigan College of Mines

Club, at Houghton, Mich., by Mr. E. R. Jones, who has kindly given his permission to make use of the following excerpt:

"For a number of years solid concrete and reinforced concrete shaft collars and shafts have been in vogue where the conditions warranted a shaft of any degree of permanence, but not until 1909 was reinforced concrete tried as a substitute to take the form and similar methods of installation as the long-used timber sets for shaft purposes; namely, at the Nos. 3 and 4 shafts of the Ahmeek Mining Co.

"In the beginning, two distinct kinds of material were used; a good grade of gravel and natural sand from a local pit; and the trap rock, through which the shafts were sinking, together with clean conglomerate sand from the Calumet & Hecla mill. Sets were molded from these two classes of material and installed with equal partiality and subsequent service has proven both to be equal to the demands made upon them. Pieces set aside for the purpose were allowed to season sufficiently that they might be given a fair competitive test, and it was found, on comparing the fractures in the two combinations of material, that the sand and cement filling the spaces between the rounded pebbles broke away from them, while the fracture in the trap-conglomerate same combination continued through the larger elements of the mixture. The gravel mixture could doubtless have been improved considerably by careful-washing, but the cost of preparation, compared with the trap rock and conglomerate sand, prohibited its use in this particular case.

"The materials finally used were as follows:

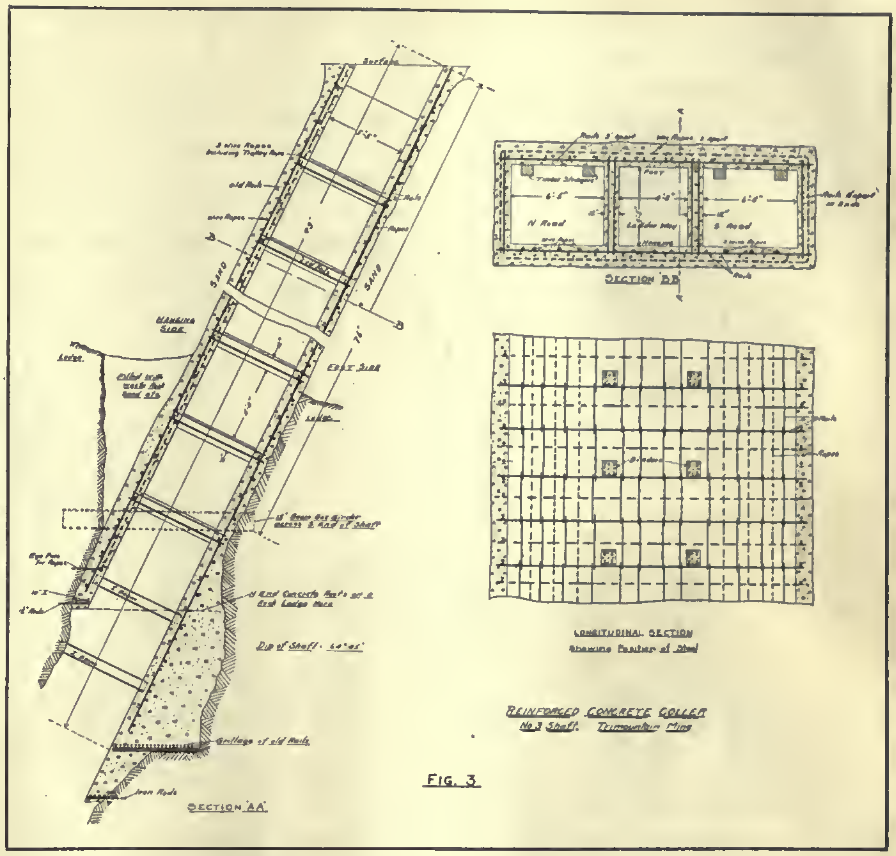
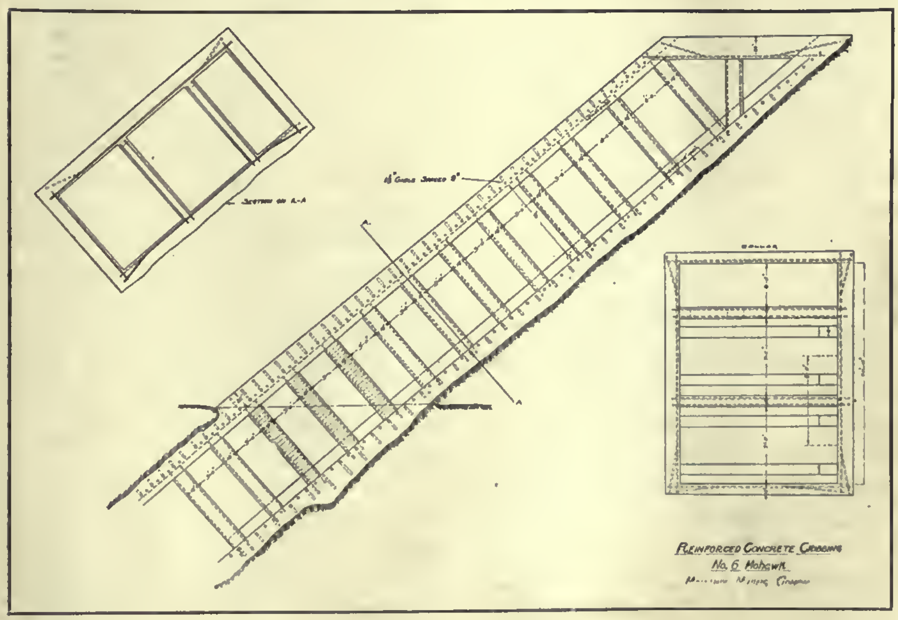


FIG. 3

"No. 1 Portland cement. Conglomerate sand. Trap rock trommeled over ¾-inch through screens. The proportions used were 1:3:5 in wall plates, end plates, and dividings, and 1:2:4 in studdles. The reinforcement in wall and end plates consisted of three ¾-inch Monolith steel bars with ¼-inch webs, crimped onto them, together with two straight ¾-inch Monolith bars. The dividings were reinforced by four ½-inch Monolith steel bars wound spirally with ¼-inch steel wire, the whole presenting a column with square cross-section. Studdles were reinforced with two pieces of old wire rope 1¼ inches in diameter. Reinforced concrete slabs were molded for the shaft lining, the material used being fines of trap rock under ¾ inch, conglomerate sand and Kahn expanded metal as reinforcement. The mixture used for slabs was 1:2:4. By way of experiment, the writer selected a piece of No. 1 hemlock plank of the same length, width and thickness of a concrete slab, which had seasoned for 1 year, sup-

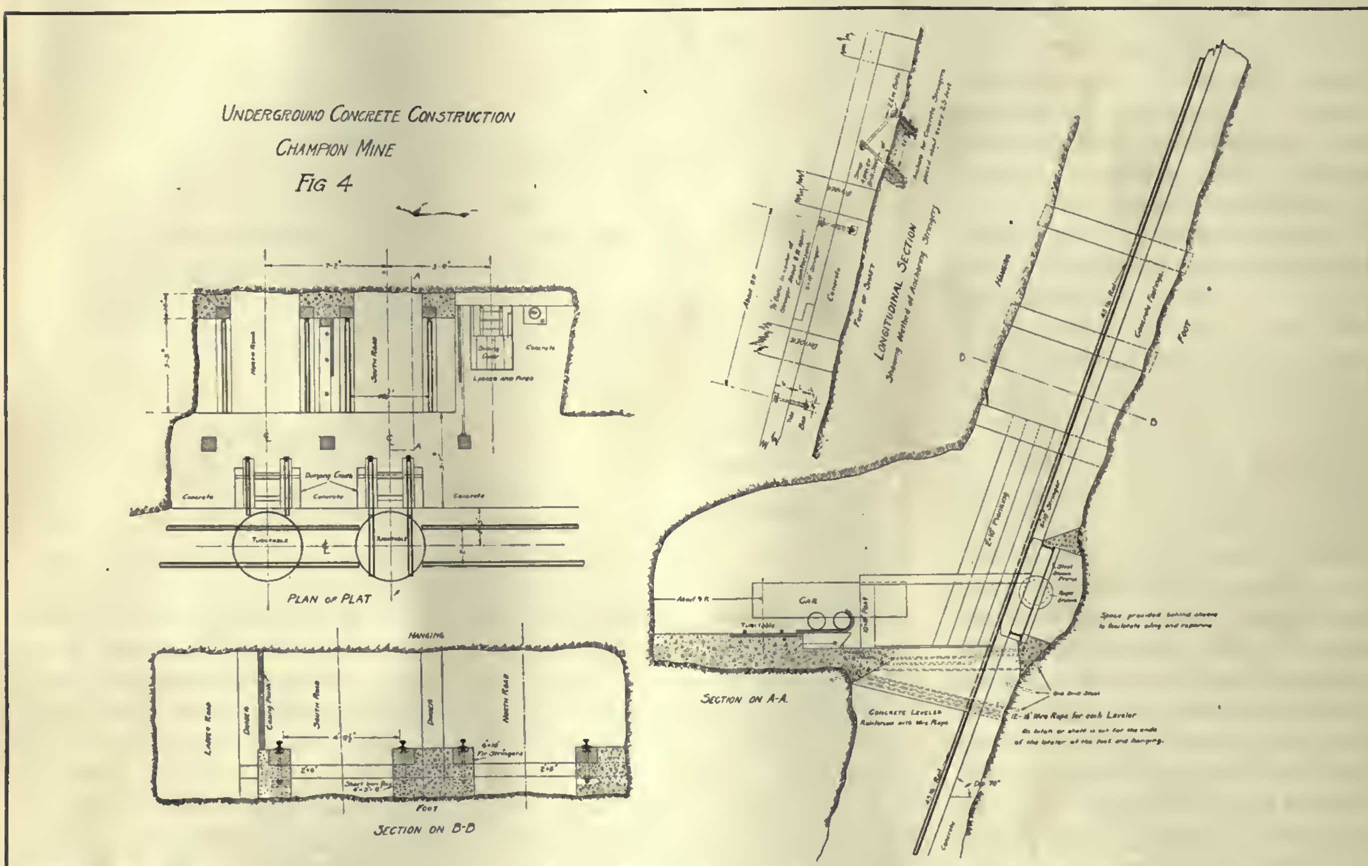


ported them at either end, and placed them side by side, and then applied an equal pressure across the center of each. Three failure cracks appeared in the concrete slab just previous to the breaking of the hemlock plank, although total collapse of the concrete slab did not occur until the pressure was considerably increased. While the method of the test employed was crude, it proved to the satisfaction of the writer that the concrete slab was much superior in strength. Considering the rapid decay of timber used as shaft lining no further comparison of the two is necessary.

"In the molding of the concrete sets 2-inch No. 1 white pine was used in the construction of the forms. These were soaked in wood preservative, and repainted with preservative on the interior each time before setting up, thus insuring them against warping and prolonging their lives indefinitely, as well as securing a smooth and easy parting from the concrete when removed. A Smith barrel-type mixer was employed in preparing the charge for the forms. The amount of water used in the mix was such that, when the batch was piled, it settled rapidly without agitation. A dryer mix was attempted by way of experiment, but due to the amount of reinforcement employed, it was found impossible to ram the dryer mix into place.

"The labor involved in making consisted of two carpenters, setting up forms and keeping them in repair; one man wheeling forms on to skidways ready for filling, returning used forms to shop and cleaning the same; one man delivering mix to forms and shoveling material into place; and one mason ramming charge into final position. With this combination of men as many as four complete sets, consisting of 64 separate pieces, have been molded in 1 day of 9 hours. In ordinary weather, the sides of the forms were allowed to remain in position over night, and then removed, while the bottoms were left in place another 24 hours. The bottoms were removed by turning the pieces on their sides, where they were left to harden 1 day longer before removal to the stock pile. All through the process of removal the sets were handled with the greatest care in order to preserve the appearance of the set and prevent cracking, which might not develop to the eye until weathered. All skidways used in making and storing were brought to a level to prevent warping and bending while the sets were green, to insure a perfect fit underground, for unlike timber; the concrete set cannot be brought to place unless perfectly true. Sets should not have been used under 60 days after removing forms, although we, through the reduction of the stock piles, have been forced to install pieces of 14 days' set, but the greatest care was observed in handling and putting in place underground.

Concrete sets 1 year old, which have been subjected to all manner of weather, can be abused somewhat and handled almost as carelessly as timber.



"As before stated, the above-mentioned sets were made for the Nos. 3 and 4 shafts of the Ahmeek Mining Co. The shafts are of the three-compartment variety—two skipways and one manway, dipping at an angle of 80 degrees. The outside dimensions of the compartment are:

"Skipways, 7 feet 6 inches high, 6 feet 10 inches wide.

"Manway, 7 feet 6 inches high, 3 feet wide, with the end plates and dividings, making the greatest span of 7 feet 6 inches. Offsets were molded in all plates 5 inches from the inside face to accommodate lining slabs. Also, holes were cored for the use of hanging bolts and bracket bolts. The wall plates, end plates, and studdles have a cross-section of 80 square inches; dividings 81 square inches. The percentages of reinforcement are approximately as follows: Wall and end plates, 5 per cent.; dividings, 5 per cent.; studdles, 3 per cent.

"It was found advisable from the beginning, because of the great weight of the wall plates, to mold them in two sections, one section spanning the ladderway and one skipway, and the other section spanning the remaining skip compartment. These two sections were connected when in place by two bolts passing through holes, cored for the purpose, and two straps of iron spanning the splice. Studdles were made for 4 feet, 5 feet, and 6 feet sets to accommodate the ground passed through.

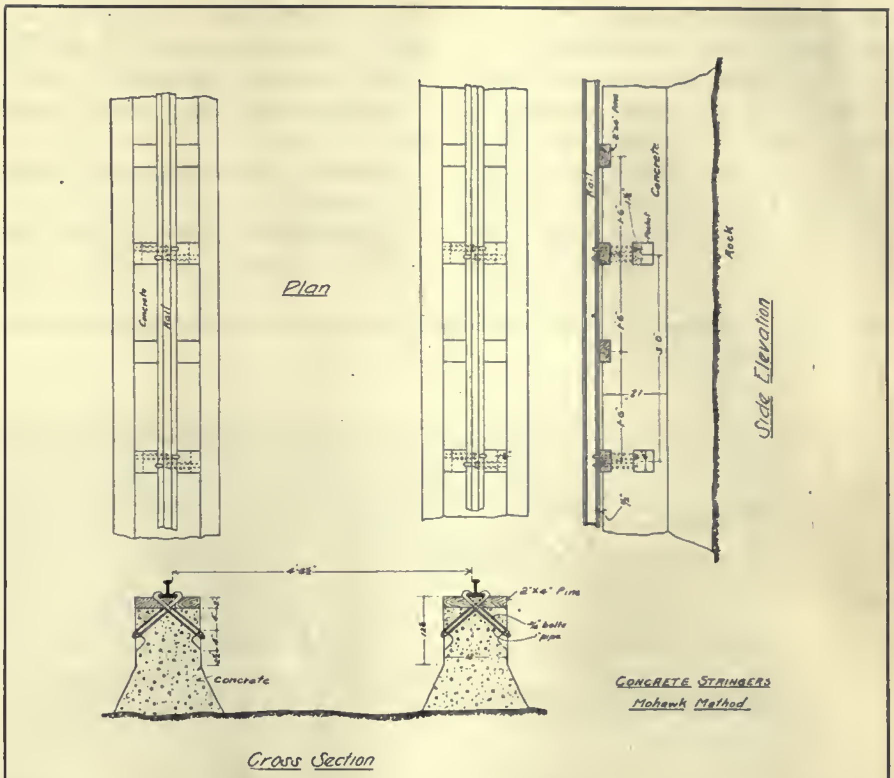


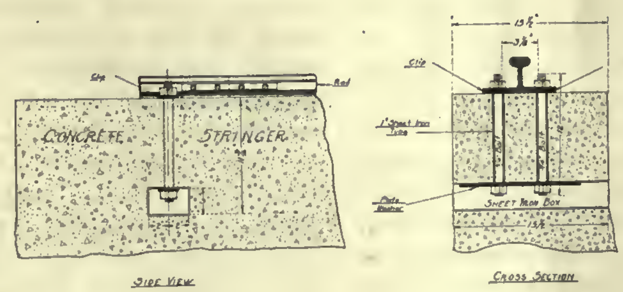
FIG. 6

"The weights of the different pieces comprising the set are as follows:

	Pounds
Long section of wall plate	1,035
Short section of wall plate	700
End plate	600
Divider	645
Studdles, 3 feet 3 inches	268
Complete set of 16 pieces	8,104

"Taking the weight of No. 1 Western fir, which has been exposed to the weather in stock piles, as 33 pounds per cubic foot, the above concrete set weighs almost three times that of a 12″ × 12″ timber set which the concrete set is intended to replace. Because of this additional weight of the concrete set, it was found necessary to increase the usual five or six men on the timber gang to seven in number. In a vertical shaft, to which the concrete sets are especially adapted, the number of men per gang might again be reduced. The sets are hung or built as the ordinary timber sets, only requiring an additional rope and block to swing the pieces in place. After the sets are wedged to line, bottoms are put in between the plates and the surrounding shaft wall, and the set is then tied to the shaft wall by means of concrete, in the proportion of 1:3:5. The concrete slabs are then put in place, and loose rock thrown behind them, filling up what space still remains between the set and the wall of the shaft.

"After the set is in place, it is extremely important that it is well protected from the blast, for, unlike the timber set, concrete will not stand the blast. For the purpose, the writer used flat timber and steel plates chained to the under side of the plates and dividings, and even



DETAILS FOR CONCRETE STRINGERS
Showing Old Method of Fastening Rails.

FIG. 5.

this precaution was at times inadequate. Where the ground was breaking easily, the sets have been as near as 12 feet to the miners, and again when the ground was especially refractory, sets 40 feet from the blast have been cut out. It is obvious that it is well to keep as far behind the mining as the ground will permit. In dangerous ground, which required timbering close up to the sinking, timber sets were used, but, had not time played an important part in the sinking, no ground was met in which concrete sets could not have been installed. With a gang of seven men, one complete set can be installed in a 9-hour shift. This permits a sinking rate of better than 100 feet per month, which was accomplished at the Nos. 3 and 4 shafts.

"The comparative cost of the concrete set and timber set, delivered at the shaft collar, is striking. The concrete set was delivered for $22.50, the timber set for $37.60. These figures are based on:

"Western fir at $28 per M., f. o. b. car.

"Crushed rock at 35c. per yard, f. o. b. shaft.

"Conglomerate sand at 60c. per yard, f. o. b. shaft.

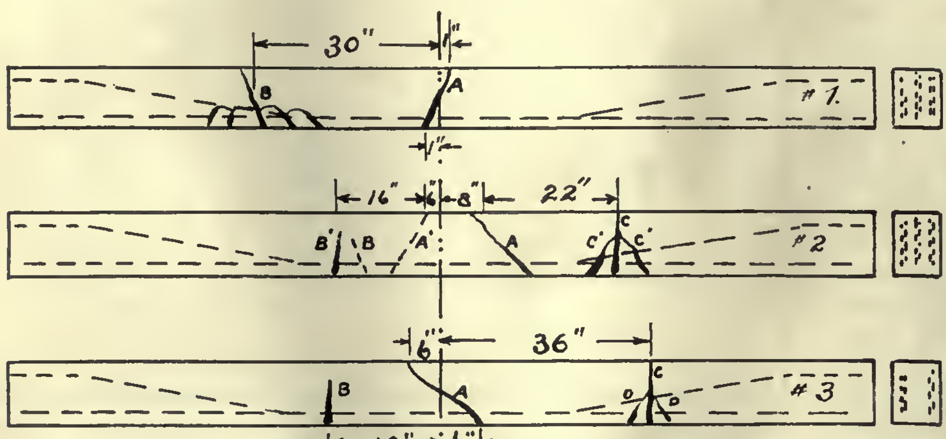
"No. 1 Portland cement at $1.15 per barrel, f. o. b. works.

"Reinforcement at $12 per set, f. o. b. factory.

"The Ahmeek Mining Co., I believe, was the first to adopt the concrete stringers, and the Mohawk Mining Co. soon followed with their use. At the Ahmeek, these stringers have been in continuous use since the beginning of operations and have required no repairs. Superintendent Smith, of the Mohawk, has informed me that soon after the stringers were installed, skip repairs increased about 100 per cent. The stringer being entirely rigid and the skip also of rigid construction, the axles of skips were found to be crystallized and the rivets working loose. This feature was overcome by molding 2-inch pine strips, after soaking them in wood preservative to prevent decay, into the stringers at intervals of 3 feet, allowing them to project ½ inch above the face of the stringer, and resting the rail thereon. The pine strips have been in place 4 years, and none have been replaced to date, and skip repairs have been reduced to normal. Possibly because of a differently constructed skip, Ahmeek repairs were not abnormally high, but the same racking of the skip body occurred and the Ahmeek company has adopted the Mohawk feature and expects to profit accordingly.

"Concrete plats, or stations, have been in use at both the Ahmeek and

Plate 1



Average area of strands = 1052 sq. in.
Average diam of strands = .041 sq. in.

#3.

$\frac{M}{bh^2}$	No. of Beam	Prop. of concrete	Age in days	Span in feet	No. of strands	≡ in size to bars	Diam of strnds	% of steel	Depth of Beam	Dist of steel from top	Breadth of Beam	Max load #s centre	at 1st crack Load	at 1st crack Def.	ult. Defl'tn
616	1	1-2-4	98	10	6	3/8	0.41	0.93	10"	8½"	8	11880	7480	0.20"	0.50"
750	2	1-2-4	100	10	6	3/8	0.41	0.93	10"	8½	8	14480	6480	0.20"	0.82
542	3	1-3-5	100	10	4	3/8	0.41	0.62	10"	8½	8	10480	6480	0.36	0.56

NO 1.

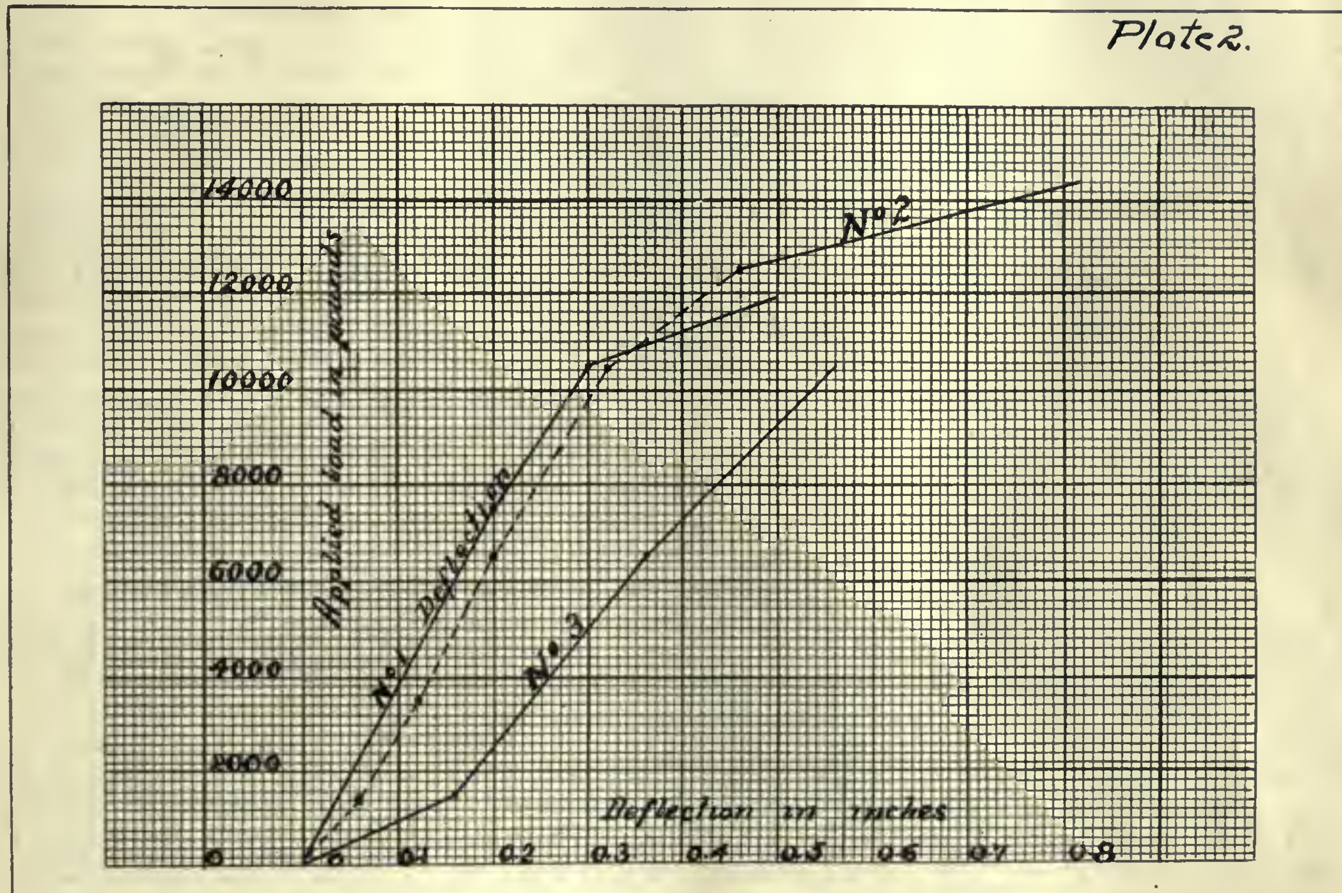
	Diam of Single wire	Circum of Single wire	Area of wire one strand
1	.067	.2105	.0035
2	.068	.2136	.0036
3	.071	.2231	.0040
4	.068	.2136	.0036
5	.094	.2953	.0069
6	.069	.2168	.0037
7	.068	.2136	.0036
8	.097	.3047	.0074
9	.095	.2983	.0071
10	.082	.2576	.0053
11	.082	.2576	.0053
12	.096	.3016	.0072
13	.082	.2576	.0053
14	.096	.3016	.0072
15	.096	.3016	.0072
16	.084	.2639	.0055
17	.081	.2545	.0062
18	.082	.2576	.0053
19	.085	.2670	.0057
			.1026

NO 2

1	.069	.2168	.0037
2	.095	.2985	.0071
3	.070	.2199	.0038
4	.095	.2985	.0071
5	.069	.2168	.0037
6	.093	.2935	.0069
7	.070	.2199	.0038
8	.095	.2983	.0071
9	.072	.2261	.0041
10	.095	.2985	.0071
11	.070	.2199	.0038
12	.094	.2953	.0069
13	.085	.2670	.0057
14	.084	.2639	.0055
15	.084	.2639	.0055
16	.084	.2639	.0056
17	.091	.2859	.0065
18	.084	.2639	.0055
19	.084	.2639	.0055
			.1078

the Mohawk for some time. They differ from the timber plat in outward design only in the cross-section of the members, which are 9 in. × 12 in., and are reinforced with old rail and wire rope, and replace the 12″ × 12″ and 12″ × 14″ timber formerly used. Holes are cored to accommodate gates for skip and dump put in as often as the hanging requires. Since the casing along the ladder road performs no other office than the protection of the men while on the ladder, or in case of a fall, plank is used for the purpose, and a 3-inch hemlock strip is molded into the dividings to facilitate the fastening of this casing."

Question has been raised from time to time, as to the suitableness of wire rope for reinforcement. Some tests of concrete beams reinforced with wire-rope strands were made at the Baltic mine, in 1910, by Mr. C. G. Mason; and the results of these tests are given in a paper that was written by him and are published herein with his permission as follows:



Deflection of reinforced concrete beams.

doors and tram rails are imbedded in the concrete, making the use of spikes unnecessary. When turntables are used on the back of the plat, the rigidness furnished by the concrete insures the trammers against derailed cars, resulting from a tilted table.

"At the present time, our company is installing reinforced concrete dividings to replace the practice of putting in 10-inch flat timber. In cross-section they are 9 in. × 12 in., and are reinforced by old rails. On the ladder road, they are placed 6 feet from center to center and between the skip compartments are

Concrete floors for shaft houses are being tried at several places and are proving satisfactory in many respects, although subjected to the hardest usage. The floors built at the Champion Copper Co.'s shaft houses were made 6 inches thick of 1:3:5 concrete, with a top finish 1 inch thick of 1 to 2 Portland cement and coarse stamp sand. The total cost was 13 cents per square foot. The materials used for the concrete were crushed trap rock, coarse stamp sand, and Portland cement.

"Through the general manager's (Mr. Denton) consent, I was enabled to present results which might be of interest to those who are in doubt as to its practical use. You who are familiar with the use of wire rope in mining, know the number of discarded 'reels' in the scrap heap, which are difficult to dispose of, being of apparently no commercial value. This rope is 1¼ inches in diameter, consisting of six strands wound around a hemp center; each strand having 19 wires. First, we made some tests on ropes which had been used from 1 to 2 years and found the ropes to contain an aver-

age area of .63 inch and would stand a breaking load of 45 tons to the original guaranteed load of 69 tons. We then unwound these ropes and tested several strands, each averaging an area of .1052 square inch. It took a load of 4,000 to 9,000 pounds to straighten the twist, with an elongation of 1.40 per cent. With a gradually increasing load the strands broke, having an ultimate load of 12,000 to 23,000 pounds. The surface of all wires available for bonding surface was found to average 1.55 square inches. See Plate 1, Tables 1 and 2. A ⅜-inch round steel bar is the nearest equivalent, having 1.18 square inches of surface. We have not, as yet, been able to test out these strands in concrete blocks to determine the bond.

"Previous to these experiments, three concrete beams reinforced with these strands were made and tested. The ingredients used in this concrete were: Alpha cement, coarse stamp sand (or tailings), and ungraded small trap rock from the mine. The average weight of this reinforced concrete was 150 pounds per cubic foot. For data regarding beams and method of failure see Table 3, Plate 1.

"Beam No. 1: This beam was loaded with a gradually increasing load and showed the first crack at point *A*, when the load was 7,480 pounds and the deflection was .20 of an inch. The crack at *B* appeared soon after the one at *A*. Just before reaching 10,480 pounds the other cracks in the vicinity of *B* began to appear; with this load the deflection was .30 of an inch. The greatest load carried was 11,880 pounds, with a deflection of .50 of an inch. The ultimate failure occurred at *B*.

"Beam No. 2: In this beam with a load of 6,480 pounds two cracks (*A* and *A*) appeared on opposite sides and the deflection was .20 of an inch. The remaining cracks seemed to appear at the same time, at a load of 10,480 pounds, with a deflection of .32 of an inch. All cracks gradually extended toward the top of the beam, with a load of 12,480 pounds, and a deflection of .46 of an inch. Finally with an ultimate load of 14,480 pounds and a deflection of .82 of an inch the beam failed at *C*.

"Beam No. 3: Here, with a gradually increasing load at 6,480 pounds and a deflection of .36 of an inch cracks at *A* appeared. Cracks *B*, *C*, and *D* appeared in order when the load was 10,480 pounds, and the deflection was .56 of an inch. This was the greatest load; ultimate failures occurring at *D*. In these beams all the cracks as they extended toward the top, gradually widened at the bottom. The failure of these beams was not caused by the slipping of the strands; which proved a very satisfactory result in this test. Had they slipped, the grooves formed by the strands, would have crushed or sheared the ridges of the concrete, but nothing of this nature occurred.

"Plate 2 shows the deflection curves for the three beams.

"As a result of these tests we were able to compute by the straight-line formula and the usual safe stress of 650 pounds per square inch in the concrete, and the per cent. .93 of steel, the safe load at the middle of a beam of this size and span, which is 2,180 pounds. The average ultimate breaking load of beams No. 1 and No. 2 is 13,180 pounds. This would indicate a factor of safety of $\frac{13,180}{2,180}=6$.

"Apparently then, it ought to be perfectly safe to use these strands with the per cent. of steel about ¾ to 1 per cent. In closing, I would suggest, when the area of steel is large, if possible, to use the whole rope, and where the area is small to use the strands in pairs as unwound from the rope, since they can be placed in almost any position, requiring less labor and time than the placing of single strands."

Concrete seems well adapted to underground use, especially as illustrated here. The effect upon it when the surrounding ground begins to give under pressure, or is under great stress, is still to be learned by experience. The Copper Range Consolidated Co. is inclined to confine the use of concrete in shafts at depth to stringers for the road bed and to the sollars and roof at stations, with the idea that should the ground around the shafts fail it will be easier to maintain the shaft if timbered than if lined with concrete. On this point, however, it is in doubt.

"Safety First"

By J. A. T.

The cry is universal now,
Shake off the rust,
We've held it in our hearts too long,
Away it must.
We'll wash the dirty filth away,
Replace it yes, without delay,
With slogan that will live for aye,
'Tis "Safety First."

This mortal enemy, "Neglect,"
Must soon depart.
For ages he has reigned supreme
In every heart.
Dethrone him for he is a knave,
His kingdom ending in the grave;
If you don't wish to be his slave,
Then "Safety Start."

Officials of the D. L. mines,
With one accord,
Are giving prizes to their men
As a reward.
For their suggestions, or a plan,
To lessen accidents to man;
Put forth the pen, do all you can,
Keep green the sward.

Thou Mighty Ruler of the earth,
In whom we trust,
Thou knowest that we need thine help;
We are but dust;
We often pray for thy great hand
To guide us to the heavenly land;
And this is always thy command,
Now "Safety First."

Kingston, Pa.

Air Receivers

The purpose of a compressed air receiver is to reduce the pulsations of the air from the compressor, and to collect water and grease carried by the air from the compressor cylinder. The receiver is intended also as an air reservoir in which a sufficient volume of air, at a given pressure, is stored to accomplish work when there is a sudden stoppage of the compressor, or when there is a demand for air for a short time greater than the compressor can supply.

The Theory of the Arch in Mining

Development of the Arching Line of Stress in the Overlying Strata When the Supporting Strata Are Removed

*By Beverley S. Rondolph**

When, through the removal of coal or other mineral, occurring in an approximately horizontal bed, the overlying strata are left unsupported, the first stress brought on these strata would be much the same as that on a uniformly loaded horizontal beam. Owing to the low tensile strength of the rocks which usually compose such strata, and the presence, generally, of more or less well-developed joints, the span over which this superincumbent mass can be carried by such action is very limited. The integrity of such unsupported strata soon comes to depend on the development of an arching line of stress carrying the weight to the solid measures on either side of the open space. Even though the lowest measures of the superincumbent strata, as exposed in the roof, may not actually fall, the elasticity of the material allows them to descend so that they no longer support the strata above but may be supported by them, when the adhesion is sufficient along the beds of stratification. In such an event the entire mass is supported by the arch.

By the "line of stress" in an arch, is meant the resultant of all the forces acting on the arch. A rod or column of material, having sufficient strength to resist the crushing effect of this stress, if placed with its center coinciding with this line would be in stable equilibrium, so far as the forces mentioned are concerned. While the phenomena connected with this "line of stress" are familiar to engineers concerned with bridges and similar structures, they are not commonly brought to the attention of mining men. A slight digression would therefore seem advisable, explaining a simple method of establishing this line in order to make clear just what is meant.

In the case of an arch ABC, Fig. 1, it is plain that the two sides AB and BC are mutually supporting at B where the thrust is horizontal. Assuming an evenly distributed load on the arch, which we will, for convenience, conceive to be concentrated at the points or nodes W_1, W_2, etc., we are prepared to locate a point in the line of stress under and corresponding with each one of these nodes.

If we assume the resultant of all the load on the half of the arch BC

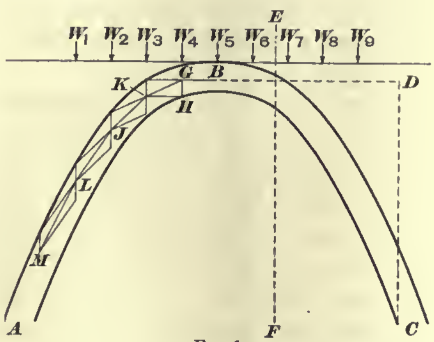


Fig. 1

to be in the line EF, and represent its value by R we will have a tendency on the part of this half of the arch to rotate about the point C at the springing line. By the method of moments, the horizontal pressure at $B = \frac{R \times FC}{CD}$. Supposing BG to represent this force it will, at G, encounter the weight of the node W_4. Constructing the parallelogram of forces we have the resultant GK. Combining this at K with the weight from node W_4 and we have the resultant KJ. Repeating this process for the remaining nodes and we have the points B, G, K, J, L, M, all in the line of stress through which it is a simple matter to draw the curve.

Such a line of stress, when lying in solid material over an excavated cavity will constitute, for all practical purposes, an arch supporting all the material above it and allowing the removal of all the material below it up to the point where this material becomes effective in resisting the stress. There will, of course, exist along and on each side this line of stress a zone of material under more or less pressure, depending for its width on the total stress and the elasticity of the material. This pressure will have a tendency to hold this material in place, just as an object can be suspended in air by pressure on its opposite sides without any other form of support.

It will at once be apparent, from the above, that the position and character of the forces acting on the arch will vitally affect the shape of this line of stress. In an arch under a perfect fluid, where the pressures are all radial acting toward a common center, the line of stress becomes the arc of a circle. With an excess of load toward the center, it takes the shape of the parabola, the focal distance shortening as the central load exceeds that on the side.

With the excess of pressure on the sides, say at an angle of 45 degrees, it assumes the shape of an ellipse, the focal distance shortening as the pressures at the side exceed those in the middle.

In the construction of arches of stone or concrete, it is the usual practice either to give the arch proper the shape of the line of stress developed by the proposed load, or to so adjust the load as to cause the line of stress to lie in the constructed arch where the material is properly disposed to meet the pressure, the rule being that the line of stress should lie wholly within the middle third of the ring of arch stones or concrete ring. The joints between all arch stones must be at right angles to this pressure in order that there may be no tendency to slide one on the other.

Should the line of stress fall outside the material of the arch, or, in the case of very heavy pressure or weak material, come very near the edge or surface, the structure will

*Civil and Mining Engineer, Tonolowa, Hancock, Md.

fail by crushing at such a point. Hence it will follow that the character of the strata overlying the bed which is being removed, as affecting the method of breaking down, will affect the position of the line of stress of the arch which supports the unbroken portion, and that an adjustment, similar to that just described, must take place in order that equilibrium may be maintained. As the load is, for all practical purposes, equally distributed, the curve will be a parabola with a longer or shorter focal distance depending on the nature of the strata, but it must lie wholly within material sufficiently firm to resist the pressure, and, when the material fails at any point in its path, there must follow a readjustment of position so that the stress may lie wholly within sufficiently resistant material.

Let Fig. 2 represent the section of a coal seam from which the coal has been removed between *A* and *B*, the roof having fallen to the irregular line *A C B*. The dotted line *A C B* will indicate the line of stress. This, it will be seen, impinges on the coal close to the edge at *A*. The stress at this point represents half the weight of the strata overlying the span *A B* which is assumed to be sufficient to crush the coal about the point *A*. The integrity of the arch being destroyed, the line of stress must seek a new position such as *D E B*. Naturally this movement will be no greater than is absolutely necessary to gain a solid footing for the arch, which will again be so near the edge of the coal already crushed that it will fail again in a short while, necessitating a further adjustment of the position of the arch. With this continuing failure and readjustment we have the well-known phenomena of a "crush" or "squeeze" advancing slowly over the workings, destroying coal as it goes.

If now a considerable body of the seam, as *A H G F*, is quickly removed we may succeed in getting a "fall" which will reach high above the seam, say to the line *F J B*, which will cause the line of stress to move quickly and reach the coal well back from the point *F*, where it is sufficiently solid to give the needed support, and the working will be said to have "gotten ahead of the crush," when in fact the crushing force has gone ahead of the working. This explains the com-

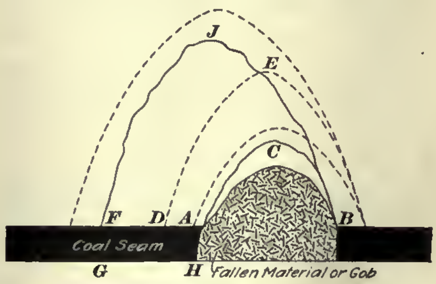


Fig. 2

mon experience of the relief at the working end of the pillar caused by an extended break in the roof over the exhausted area.

Under other conditions, especially when the arching line of stress has a wide span, thus carrying a large amount of weight, it may prove too much for even the solid coal well back from the end of the pillar; and we will have the phenomena of crushed coal, broken timbers and creeping floor, etc., well down the room or stall, while the end of the pillars will be free from any trouble, as they carry only the small amount of material which is below the line of stress. This condition will sometimes be cured automatically by the material falling from the top of the cavity, over the exhausted area, in such a manner as to fill the space between the material already down and the undisturbed measures, in such a way that the opposite limb

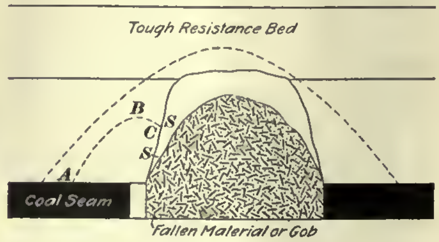


Fig. 3

of the arch, the right hand in the figure, will find support on this already fallen material and thus shorten the span of the arch and lessen the total weight, as illustrated in Fig. 3.

When the break has reached the surface, this filling takes place more rapidly owing to the fracture of the overhanging beds along the edge of the break, and the arch having a new point of support for its inner or right hand limb, Fig. 3, the conditions are ripe for further working undisturbed under the smaller arch.

While the general shape of the line of stress, in the cases under consideration, is the parabola, for all practical purposes, the ratio between the span and the "rise" or height of the arch will vary much as the material varies in which it exists. After the fall of the first mass the cavity grows through the crushing and falling of the material along the top of the arch due to the pressure along the line of stress, and by the splitting off, along the joint planes, of the material on the sides, due to the same cause. Since the pressure along the upper portion of the line of stress is manifestly less in a high sharp arch than in a low flat one, the shape of the arch, in this respect, may be expected to vary with the capacity of the material to withstand this stress. Hence there will be a high arch in a soft material with numerous joints and a flat arch in tough material with fewer joints. This may be verified practically by the examination of old drifts or tunnels where the overlying material has had an opportunity to fall and take the shape due to the conditions without regard to other influences.

If then the cavity in its upward progress encounters a bed of tough resistant shale or sandstone, it may fall so slowly that a large area may be opened by continuous mining during this delay, resulting in a heavy weight along the line of stress, due to the wide span, and crushing the coal, either at the working end of the pillar or at such point along the course of the room as the line of stress may meet the coal as shown in Fig. 3. Such a crush is not likely to find relief until the overlying measures are sufficiently broken down to fill the space *S S*, and allow the development of a new smaller arch of stress *A B C*, which

having less span and, consequently, less load, will transmit less load to the point A.

The topography of the surface about the point where the break reaches it may also be the cause of the crushing of a working pillar as shown in Fig. 4.

Let $A B C$ represent the line of the surface; then, when the crest of the cavity breaks through at B, the mass $A B D$ will no longer have the support of the opposite side of the arch, and the coal at D at the working end of the pillar will have the weight of this mass, acting with more or less leverage, directly on the end of the pillar, and this may readily amount to enough to cause serious crushing which will not be relieved until enough has broken off to fill the space $S S$ over the fallen material so as to admit the formation of a new line of stress resting on this pile of fallen material, as shown in Fig. 3.

Those who have had to do with the mining of coal under practically level surfaces have probably encountered cases where, over more or less extended areas the ground failed to settle with the rest of the surface, when the coal was removed, and the foreman in charge of the work has been suspected of leaving coal behind which might have been mined.

This may result from a condition shown in Fig. 5. The coal to the right of $A B$ has been worked out and all the material fallen to the surface. This has filled up to the solid, from B up to the surface, and a new line of stress $B F C$ is established, with its foot resting at B. As the work is continued the crest of this new cavity will reach the surface somewhere about E. The material from this break falling down and filling the cavity between the pile already fallen and the solid toward A, would support the surface about A indefinitely. Further operations, in the regular course, would bring the remaining surface down to the level of that to the right of A or along the dotted line $F G$, leaving the portion about A at the original level as though the coal was still under it.

The theory developed in this discussion does not suggest very much in the way of avoiding or preventing the difficulties mentioned, but "forewarned is forearmed" and a

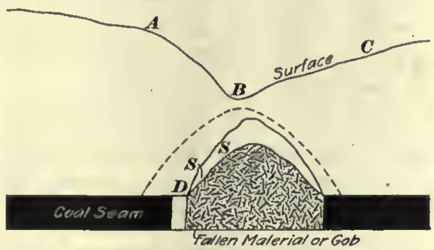


FIG. 4

foresight of what is to be expected may do much to mitigate an evil.

A careful study of the overlying strata and surface, and a record of experience should go a long way toward enabling one to prophesy the outcome as each panel of work is drawn. As all the movements above described take place slowly, much can be done by pushing the work at the proper times. Untoward conditions can sometimes be thus avoided altogether. This, of course, involves concentrating the force on the threatened district, together with provision for taking care of the coal thus hurriedly brought out. Naturally this can be more readily accom-

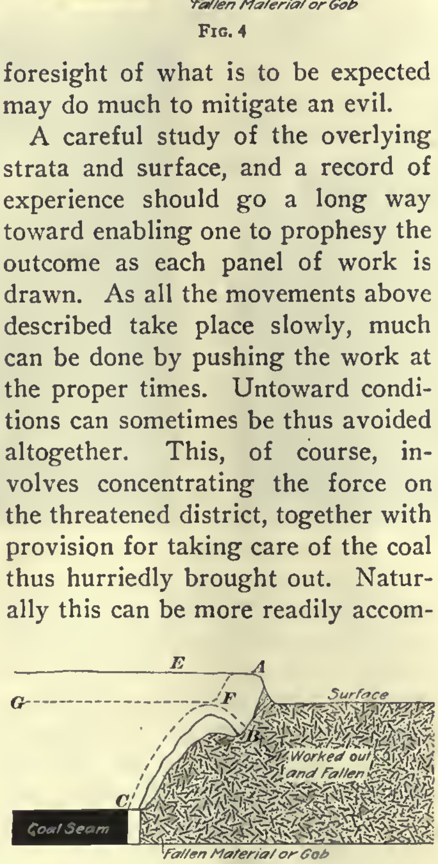


FIG. 5

plished if it is known beforehand about when it will be necessary.

For the sake of simplicity this discussion has been confined to the drawing of pillars, but it is apparent that the principles apply with equal force to longwall work. Longwall withdrawing differs only from pillar work in that there are fewer approaches through the coal to the working places, while in longwall advancing there are none, the approaches being maintained through the fallen material or "gob."

First-Aid Contest, Superior Coal Co.

Written for The Colliery Engineer

The third annual first-aid contest of the Superior Coal Co. was held at Gillespie, Ill., in the Colonial Theater, Tuesday, December 8, 1914. The contest was given under the auspices of the American Mine Safety Association, Local Union No. 730 of mine No. 1, and the Superior Coal Co.

The meeting began at 9 A. M. Mr. James Boston, chairman of the committee on arrangements, introduced Mayor Rice, of Gillespie, who welcomed the contestants and visitors and presented them with the key of the city. He referred in a most appreciative way to the rescue and first-aid work done by the Superior Coal Co. under the direction of General Manager John P. Reese; Superintendent John Ross, and James Boston, in charge of the rescue and first-aid work of the company. Although the weather throughout the day was very inclement, the crowded opera house gave evidence of the general interest that has been aroused in the community by the welfare and forward movements of the Superior Coal Co.

At 9:30 the individual contests began and in them 36 participated. The problem given was as follows:

"A man lying down undercutting coal with a pick is caught by a fall of coal and sustains the following injuries: Laceration of the right side of the scalp; right ear torn off; and the right jaw broken."

This contest was a very keen one and so close were many of the contestants that several ties had to be run off, so that the contest occupied the greater part of the forenoon. The judges for the different events were Dr. A. F. Knoefel, of Terre Haute, Ind.; Dr. C. Hopkins, of Chicago, Chief Surgeon of the Chicago & Northwestern Railroad; and Dr. H. C. Blankmeyer, of Springfield, Ill., representing the American Red Cross Society. The recorders of the results were F. F. Jorgenson, of Gillespie, chief engineer of the Superior Coal Co., and Prof. H. D.

Easton, of Springfield, instructor in the Illinois Miners' and Mechanics' Institutes.

At 1 P. M. a two-man contest was staged, and the problem given was to treat a compound fracture of the right leg and laceration from which red blood was flowing. Eighteen teams were scheduled for this contest.

At 2 an exhibition of first-aid work by a team of school boys was given and this was undoubtedly one of the most interesting events of the entire day. It gave evidence of the very careful work done by Mr. Boston and showed the interest that he has been able to arouse. The boys worked with precision and were apparently not at all flustered by the attention of the crowded opera house.

Exterior of Rescue Station

Interior of Rescue Station

At 2:15 the team contest began and the problem was as follows:

"Trip rider is hurt. One hand has been cut off, right clavicle broken, fifth, sixth, and seventh ribs broken, suffering from shock and spitting blood." Nine teams were scheduled in this event, including the teams from the several mines of the Superior Coal Co., and also teams from the Maplewood Coal Co. at Farmington, Ill.; Big Creek Coal Co. at St. David, Ill., and the first-aid and rescue corps of Breese, Ill.

All of the contests were run off on the stage of the opera house, and for the team work three teams at a time competed, the teams being separated by screens, so that no team could profit by or inspect the work of a neighboring team. Throughout the contest every effort was made to have the work fairly done, and after the call for contestants no one was allowed to go on the stage, excepting the officials and the contestants. The contests closed about 5 P. M.

At 7 P. M. a large crowd came together again in the opera house when the meeting was opened by representatives of the several organizations interested in the meet. Addresses were made by Doctor Hopkins, Mr. Reese, and representatives of the United Mine Workers. These were followed by moving pictures, furnished by the Federal Bureau of Mines, showing the methods of mining and handling coal underground.

The contests were conducted under the rules of National American Mine Safety Association, each team consisting of five men, one acting as the patient. The contestants furnished their own material, excepting stretcher. In the individual contests 18 prizes were offered, consisting of cups, medals, articles of wearing apparel, eatables, cigars, cash prizes, etc. These were furnished by the Superior Coal Co., the American Mine Safety Association, and by the business men of Gillespie. In the team contest nine prizes were offered, consisting of a trophy cup, medals of the American Mine Safety Association, medals offered by the Superior Coal Co., and medals given by the business men of Gillespie. In the two-men contest four prizes were given by the Superior Coal Co. consisting of two solid gold rings, two pairs gold cuff buttons, two fountain pens, and two gold stick pins.

So keen has the interest in rescue and first-aid work been amongst the employes of the Superior Coal Co. that two separate associations of the American Mine Safety Association have been formed. The rivalry between these two associations is very keen.

The Superior Coal Co. has built and equipped, in Gillespie, a mine rescue station in which are an overcast, chest weight, tunnel, etc.; in fact, all of the appliances that are needed for conducting the tests prescribed by the Illinois Mine Rescue Station Commission before a certificate can be granted by the Commission.

Spontaneous Combustion

When coal heats to 150°F., the temperature increases rapidly, and when 212 degrees is reached the coal must be moved to prevent spontaneous combustion. When 485° F. is reached, coal will ignite when exposed to the air.

Reinforced Concrete Props

And Beams in Mines—Results of Tests Showing Influence on Concrete, of Amount of Water, Reinforcement, and Age

By S. M. Dixon, M. A., M. Sc. Inst. C. E., M. C. I.*

The use of reinforced concrete is becoming general for pit-head work, such as bunkers and hoppers; and in a few mines in Great Britain it is used on a large scale below ground, some of the principal pits being Baggeridge, near Dudley; Sneyd, near Stoke-on-Trent; and Tunnel pit, Haunchwood, near Nuneaton.

Plain concrete is not used much in mines, one reason being that time is an all-important quantity in mining, and the methods which give the full width of the roads immediately they are timbered, seem preferable to those which need temporary support and block the narrow roads for considerable periods. To the miner the use of timber is now instinctive, and the many changes in his work necessitated by the adoption of concrete and reinforced concrete seem irksome. The engineer is also to blame in some cases because, without studying the special conditions, he merely aims at substituting one material for another which, owing to years of experience, is being used in the forms to which it is most adapted. For instance, in early days before suitable methods were devised for combining timber and iron in bridge structures, the masonry arch was imitated; and again, the timber arch was imitated in cast iron, and now in some cases engineers who use reinforced concrete pay too little attention to the form of the design, and to a large extent imitate structures in steel and wood or even masonry. Without doubt in some cases this may be necessary, but in many cases it could be shown that economy would be obtained by using the material in the special forms to which it is adapted. To a very limited extent, therefore, do I anticipate that beams and posts of reinforced concrete will be used in mining as substitutes for timber, but after a complete study of the possibilities it ought to be possible to design some really efficient substitute for timber in many cases.

*Professor Civil Engineering at Birmingham University, England.

Of course it is only in main roads and permanent work in mines that it is anticipated there will be any extensive use of reinforced concrete. The strength of the timbers used now in mining was fully discussed by Professor Louis, and he states that the strength of larch props is 3,360 pounds per square inch, and of Scotch fir, 2,688 pounds per square inch, when the timber in each case is thoroughly seasoned, dry, and also fully grown; while the strength of wet timber is from 40 to 50 per cent. less. These experiments were made with ordinary pit props 4 feet long, and Professor Louis states that the prop has the same strength whatever its length, under the ordinary conditions of practice. It is evident that frequently in mines the props and beams will be wet, and therefore, according to these figures, the existing strength of a larch bar should not be assumed to be more than 1,780 pounds per square inch, which will certainly be less than a well-made reinforced concrete post 4 months old. Besides, in a mine dry rot quickly attacks timbers unless they are constantly wet.

The cost of timber for mine work is continually increasing, therefore substitutes have to be found for timber where the work is to be permanent, and they are usually of steel. Steel beams are used instead of collars, and at the ends a clip on the lower flange affords a simple and effective method to keep in their proper position the steel posts used instead of the side props. If the roof needs support between the beams, timber is generally used, whereas concrete is sometimes used between the props at the sides. It is evident that reinforced concrete slabs with rock packing, or concrete filling, if excessive loads are expected, might be most effectively used in conjunction with steel beams.

No doubt one of the chief reasons why concrete has not been used more in mines is that it takes considerable time to attain its ultimate strength. It is possible, therefore, that a method of supporting main roads in which can be used posts, beams, and slabs, manufactured and stored for at least 6 months, will be found economical in some cases.

In arranging a preliminary set of experiments on the strength of beams and posts of reinforced concrete for mine work, the results obtained from beams of 8 in. x 12 in., and triangular 8-inch side cross-section, were compared. All the concrete used was of the same composition, and was made under as similar conditions as possible. The proportions selected were 1:2:5. The sand was sharp and the gravel was screened between 1 inch and ¼-inch spaces. The concrete was mixed wet, that is, with about 8 per cent. of water, experiments having been previously made on the effect of varying the amount of water in this concrete. The results are given in Table 1.

Table 1. Influence of Amount of Water in Strength of Concrete

Per Cent. of Water	Age in Days	Average Compression Strength Pounds Per Square Inch
6	38	1,247
6	64	1,543
6	121	1,350
8	37	791
8	66	1,253
8	132	1,260
10	35	390
10	64	750
10	130	1,010

These results seem important, since in most reinforced work wet mixtures are required, and till the concrete is over 2 months old the consequent diminution in strength is very serious. The cement was slow setting and uniform in quality. Each barrel was tested according to the British standard specifications, the strength being: Pounds per

square inch at 7 days, 473; pounds per square inch at 28 days, 635; and the time of setting 3⅓ hours. The steel used had a tensile strength of 28 to 30 tons per square inch, and a yield point at 20 to 21 tons per square inch; modulus of elasticity 30.8×10^6 pounds per square inch. All the tests on the beams and posts were carried out at the age of 2 months. About a hundred cubes of concrete 6 in. × 6 in., made the same time as the beams, were tested at 2 months, and gave an average compressive strength of 1,600 pounds per square inch. During the last 5 years I have carried out many tests on 6-inch cubes and in no single instance has a strength of 2,000 pounds per square inch been obtained when the age was under 2 months. The gravel, which was fairly uniform in size, passed a 1-inch sieve. The voids were 36 per cent.

The forms were removed 3 days after casting, and the concrete was not allowed to dry for 6 weeks.

TESTS OF BEAMS

In testing the 12 in. × 8 in. beams the supports were 7 feet 6 inches apart; the load was applied at two points 3 feet 6 inches center to center in the method usually adopted. Table 2 shows the result of the preliminary tests.

TESTS OF POSTS

In making the posts for these preliminary experiments, only one rod was used for reinforcement in each case, and the rods were only 7 feet 8 inches long, this leaving 2 inches of concrete at each end, so that the rod did not come in contact with the crushing plate of the machine. The only reason for reinforcing the posts is to make them portable, as it was considered that the crushing strength of the concrete would be ample for its work, provided that it could be developed. It was anticipated that economic reasons would prevent the use of spirally-reinforced concrete columns of such small dimensions. As was expected, the square columns gave better results per square inch than the round columns. Table 3 shows the results of tests on the first set of posts made. The results, show, however, that there is no difficulty in making, storing, and transporting suitable beams and posts of concrete whose proportions are even as poor in cement as 1:2:5.

The cost of these members, when cast in steel molds and with the simple reinforcement described, can be readily determined, according to local conditions. The posts, being cast vertical, needed hardly any ramming, and from their moderate height presented no difficulties. Both props and beams were easily handled, the beams weighing about 100 pounds per linear foot.

The increase in strength with age up to 12 months should be very valuable in the case of mining work. Owing to gradual settlement, the load on the beams and posts in the headings is often found to increase with time. But when great pressures are expected, the only satisfactory method of resisting them is by a complete shell, in which the invert supports the side walls. Here, then, are the real opportunities for the engineer in reinforced concrete work. It is necessary to arrange for this work at the beginning, because it would be found very difficult to replace timber work with a reinforced concrete arch, which itself would need to be supported on centers for a considerable time.

At Baggeridge the pit bottom, whose height is 60 feet and about one-third mile below the surface, is all reinforced work, and also some of the main roads; but though reinforced, the concrete is very thick, and it will be seen in many cases, when reinforced work is underground, that little confidence seems to have been placed in the reinforcement. Except on the Continent, it is only in a few isolated cases where sections reinforced with steel are made lighter than would be safe with cement only.

TABLE 2. TESTS OF REINFORCED BEAMS, 8 FT.×1 FT.×8 IN.

No.	No. of Specimens	Reinforcement Kind	Per Cent.	Breaking Load Equivalent: Uniformly Distributed Load Tons Per Linear Foot	Method of Failure
1	3	2 straight ½ in.	.45	1.0	Tension
2	3	2 straight ½ in.; 1 bent up ½ in.	.67	1.3	Diagonal tension
3	3	1 straight ½ in.; 2 bent up ½ in.	.67	1.1	Plain and diagonal tension
4	3	1 straight ½ in. top; 1 straight ½ in. bottom; 4 bent up ½ in.	1.34	1.4	Diagonal tension

TABLE 3. COMPRESSION TESTS ON SQUARE AND ROUND POSTS—CONCRETE PLAIN AND REINFORCED, 8 FEET LONG. AGE OF CONCRETE (1 : 2 : 5) 2 MONTHS

Number	Number of Tests	Section	Reinforcement	Crushing Load Pounds Per Square Inch
1	2	8 in.×8 in.	Plain	1,270
2	2	8 in.×8 in.	One ¾ in.×¾ in., 7 ft. 8 in. long	1,266
3	2	8 in.×8 in.	One 1 in.×1 in., 7 ft. 8 in. long	1,300
4	2	8-inch diameter	Plain	1,234
5	2	8-inch diameter	One ¾-inch diameter, 7 ft. 8 in. long	1,020
6	2	8-inch diameter	One 1-inch diameter, 7 ft. 8 in. long	1,068

Coal Mining in South Africa

J. E. Vaughan, the Natal Inspector, in his recent report makes an interesting comment on the labor question as it presents itself down there.

The Kaffir corn crop was a record one in many parts of Natal and Zululand, and the native will not work while there is beer to be had. There is such a scarcity of labor that it has been suggested that cheap white labor be imported. Several new mines are starting up, and the mine inspector advises a very liberal scale of diet, as the native's stomach is his first consideration.

Compensation Laws and Accidents

Opinions of Operators in Various States as to Whether Such Laws Cause an Increase or Decrease in the Number of Accidents

*By Prof. E. N. Zern**

With a view to securing information on this question, the writer sent the following letter to a number of mine operators:

Dear Sir:—The enclosed questionaire is being sent to coal operators in the states of West Virginia, Illinois, Ohio, Kansas, and Washington for the purpose of obtaining some information on how the compensation laws of the various states are affecting the occurrence of accidents.

It is sometimes stated that compensation for injury promotes carelessness, and encourages malingering. It is desired to have the benefit of opinion from those who have observed the workings of the law. Any information you care to give will be of great assistance in reaching a conclusion.

1. Since the compensation laws went into effect, have accidents increased or decreased at your mine?

Replies: 1, increased; 8, decreased; 15, no change.

2. Can you estimate the percentage of increase or decrease?

Yes, 1 to 50 per cent. increase. 15 answered "no."

3. Can you state whether or not the compensation laws have a tendency to make men careless or indifferent?

Replies: Twenty-five answered "no tendency." None answered that they had a tendency.

4. Have you observed any tendency to malinger?

To this question 12 replied "yes," and 14 "no."

5. Remarks.

You will note there is included the subject of malingering, discussion on which is frequently linked with that on compensation laws.

Thirty-five replies were received. Some of the questions, such as No. 2, are difficult to answer with accuracy, and there was plainly observable in all the replies, a tendency to avoid answering where it could not be done with fair accuracy. Again, the compensation laws being comparatively new to all the states, there is a feeling that the system is on trial, and that the expressed observations of today may be the discarded views of tomorrow. For these reasons, but a few of the replies came with answers to all the questions. However, it will be apparent from this caution displayed that the information secured is made all the more dependable.

To explain the answers more fully than is possible on a tabulated sheet, extracts will be read from replies wherever it is thought they may be of interest. The following refer to question No. 1 and are from West Virginia.

"The accidents have decreased very materially, both fatal and non-fatal. Including October 1, 1912, to October 1, 1913, we mined 102,176 tons of coal per fatal accident. Including October 1, 1913, to October 1, 1914, we mined 242,643 tons of coal per fatal accident."

"The following is the number of tons per accident at our mines for the past 8 years:

1907........	17,000 tons, or	63 accidents
1908........	11,140 tons, or	76 accidents
1909........	14,200 tons, or	88 accidents
1910........	21,430 tons, or	70 accidents
1911........	16,800 tons, or	71 accidents
1912........	12,090 tons, or	75 accidents
*1913........	6,350 tons, or	132 accidents
1914........	7,000 tons, or	176 accidents (to date)

*Fifty-nine of the 132 accidents occurred in the last three months of the year. Note the increase after October 1, 1913, when the Act went into effect."

This table is illuminating, in that it shows the greatly increased number of accidents now reported, and which previous to the enactment of the compensation laws were disregarded.

"There has been a reduction of at least 50 per cent. in non-fatal accidents since the act became effective. This is due very largely to the fact that we have been extremely vigilant in removing causes of these minor accidents, and have placed in charge of our mines a competent safety inspector, to whose vigilance much credit is due."

"We do not feel that we have any reason to think that accidents have increased at our mines; in fact, we rather think the reverse is actually the case, due possibly to the effort made by our people to promote interest in 'Safety First' work, and due also to the more rigid enforcement of the mining laws."

"Fatal and serious accidents have been less than at any previous time in the history of the mine."

The next excerpt refers to the state of Kansas:

"It is evident from the records of Kansas accidents that the non-fatal accidents have increased almost 100 per cent., while the same records show that the number of fatal accidents have decreased about 20 per cent. during the same length of time as compared with former years in which there was no compensation law in force."

The next two are from the state of Illinois:

"My observation has been that there have been fewer accidents since the passage of these laws as a general proposition, except that within the last month there was one accident at one of the mines, at Royalton, in which 52 men were killed."

"Our first experience in Illinois under a compensation act began about 1911 and we are now operating under the second so-called compensation law, and about all that we know definitely about the matter is that these laws so upset the stability of the law as it was before the passage of the first of these compensation laws that no one is able to determine at this time just what the ultimate effect of a compensation law will be as to increase of accidents or otherwise."

In answer to question No. 3, whether or not the compensation laws have a tendency to make men careless or indifferent, the follow-

*Read at the Pittsburg meeting of the Coal Mining Institute of America.

ing comments from West Virginia are of interest:

"No. We think that the compensation laws have a tendency to make the men more careful, due to increased care and efficiency of foremen and safety inspectors."

"We think not. Mines are running on short time, making compensation small because of poor earnings on which it is based."

"No. I believe no thought of accident is in the mind of a miner until it happens. Trivial accidents are now reported, such as mashed finger or scratched leg, which before would hardly have been reported."

"Speaking only from our standpoint of operation, we felt from the beginning there might be a tendency to carelessness. To guard against anything of this kind, we have put into effect several very strict rules to be followed by the mine superintendents and mine foremen and have placed all necessary danger signals and signs that could possibly be used around a mine. We believe that as far as our mines are concerned, the dangers have been lessened very materially."

A reply from Ohio puts it in this wise:

"It has not. Injured men receive only part of average wage. Economically it pays to be careful, and men prefer health and strength to compensation."

Question No. 4, relative to the tendency toward malingering brought the following comments from West Virginia:

"No, but in some cases there has been a tendency to impose on the Compensation Fund, both by the men and, at times, some of the medical profession. However, it never happens twice from the same source on account of the stringency of the law."

"It is human nature for a man not to make every effort to go back to work as, of course, he feels if he should make a mistake and go to work too soon his compensation would be cut off, while he is sure of this compensation if he is still sick. Therefore, I would say that it does tend to retard the recovery of the individual, although whether this can be termed malingering or not, I would hesitate to say."

"We feel that there is undoubtedly a disposition on the part of some of our foreign workmen to take advantage of the Compensation Law by deliberately sustaining minor injuries, such as crushed fingers, toes, or bruises that will give them excuses to absent themselves from duty, and receive compensation for time lost. We also think there have been some cases where slight injuries, honestly sustained and properly treated by physicians have been prevented from healing by the act of the person injured."

An observer in the state of Washington replies thus:

"Reports of minor accidents were not made prior to the Compensation Law going into effect. Since this law has gone into effect, I have noticed that injuries which would under former conditions cause a workman to lose a few days are allowed to run for a much longer period. This is noticed at mines which are on half time more than at mines which are on full time."

The following is from the state of Kansas:

"I am convinced that men will incline to impose on the law by nursing their wounds and in many cases pretending injuries that do not exist. However, I believe that sooner or later the imposition on the law will cease and that the Compensation Law will be a benefit to all concerned."

Under the head of "Remarks" were found some very interesting views on Compensation Laws. The first submitted are from West Virginia:

"Compensation satisfies the men as far as we can tell."

"I consider the present law very good, with some room for improvement in administration in some particulars."

"Owing to irregular and short work, injured men, as a rule, are disappointed with the amount of compensation, some of them expecting half of what they could earn when working full time, rather than compensation based upon actual earnings previous to injury."

"I believe we have a very good compensation law in our state, the benefits going directly to the distressed ones without very heavy cost to employer or employe. The compensation to those who are injured seems sufficient to carry them over."

"We are very much in favor of the present law, because it operates to make the officials in charge of the mine more careful and to enforce discipline and protect the workers and their families in case of being injured or meeting with a fatal accident."

"Although it costs the operators about three times as much as the old liability insurance, nevertheless it is the best law that was ever passed in West Virginia and is very satisfactory to the operators, and in most cases to the men."

The following is from Illinois:

"Up to date the law which we have seems to receive the condemnation of both the operators and miners."

The conditions in Ohio would seem to be different, if we may judge from the following:

"Laborers approve Workmen's Compensation in this state. Employers in some cases oppose, but, as a rule, it is approved by them also. Coal companies pay somewhat more under this system than under the old liability insurance."

From the variety of views submitted on the various points involved in the operation of the compensation laws, the following conclusions may be drawn:

1. The majority of opinion is that compensation laws have no effect on the occurrence of accidents, but,

2. There is a belief amongst many that they actually reduce the occurrence of accidents.

3. Opinion is practically unanimous that compensation laws do not increase accidents, and that they do not promote carelessness amongst workmen.

4. On the question of malingering, there is a divided opinion as might well be expected. Twelve have observed the tendency and fourteen state they have not encountered any cases.

The Inspection of Mines

*By J. L. Mullen, Mine Inspector**

The inspection of mines was first created with a view to eliminate, as far as possible, accidents, fatal and non-fatal, to the lives of those employed in the production of coal.

Naturally, an inspector's first thought when he is about to examine a mine is the safety of those employed therein, and this should be his predominating thought all through his inspection, which should start by a thorough examination of the fan, principally to ascertain the number of cubic feet of air moved by its maximum speed. He should then proceed to inspect the mine roof along the traveling roads, and see that the different causes by which men may be injured, are reduced. His next duty will be to examine all working places, and the entrances to all worked out, or temporarily abandoned, places. When visiting the different sections, his foremost duty should be to instruct all men in the proper method of doing their work; to see that the mining laws and the company's rules are obeyed, as this, more than anything else, will help to eliminate both fatal and non-fatal accidents. Should any dangerous condition come within his observation, he should have it rectified before leaving the place, or remove the workmen and have the place fenced off in such a manner as to warn all workmen of the danger.

He should see that all places are driven on line, so that tracks may be properly laid, thus preventing, to a great extent, accidents which occur through derailments owing to improper track laying. All switch points, frogs, derails, and guard rails, are to be protected by blocks to prevent persons from having their feet caught and being injured in this manner. The inspector should see that there is a space of at least 2½ feet, on each side between car and rib, where more than one car trip is hauled; also that it shall be kept free from obstructions; that man holes are made along all haulage roads at distances not to exceed 80 feet and that these be kept whitewashed; further that electric lights are placed every 150 feet, and also placed at all motor switches.

The examination of all feed, trolley, and machine lines should next engage his attention, and he must see that they are properly put up and so guarded as to protect any person from coming in contact with them, and receiving a dangerous electric shock.

He should see that all breakthroughs, except the last, are bratticed with suitable material, and that at least 12,000 cubic feet of air per minute is passing through the last breakthrough of each pair of headings, whether or not, and that the air is conducted around the working faces of rooms by means of checks across the heading, and that doors, where used, are hung so as to close automatically. It is his duty to see that all pumps, mining machines, haulage motors, and other machinery are properly safeguarded, and that lights are placed in such positions that the operator has sufficient light to work in safety, as well as to operate his machine. Notices are to be posted by him to the effect that all machinery must be stopped before oiling, wiping, or repairing; he should see that safety mottoes are hung at the entrance to each section, and at the mine entrance, and that lights are kept burning in them; also that letters regarding accidents which have been taking place are posted at the entrance of each section, to inspire workmen to have the grand old motto, "Safety First," on their minds at all times. At the entrances to abandoned places, or where final robbing has been done, fences are to be erected and danger signs posted thereon, to warn persons to keep out.

Finally, the inspector should make it his duty to inform mine foremen and assistants, that all work about to be done must be done in safety, regardless of time or cost, and that all foremen, who come in contact with their men more often than the inspector does, make it a special point to teach their men the principles of safety first, as laid down by the state and company, and have them realize that it is for their benefit and that their safety depends entirely upon the efforts they put forth to protect themselves, as well as others, by obeying those rules. With the cooperation of the miners, foremen, inspectors, and superintendents, accidents will be reduced to a minimum, and we can point with pleasure and enthusiasm to our motto: "Safety First."

*Paper read at Safety-First Banquet, United States Steel Corporation, United States Coal and Coke Co., Gary, W. Va.

Anthracite Records

The Truesdale colliery of the Lackawanna Coal Co. has the distinction of having the greatest output of coal of any colliery in the anthracite region. The Prospect colliery of the Lehigh Valley Co., near Wilkes-Barre, ranks second in the list of coal production and is closely followed by the Woodward colliery of the Lackawanna Co. at Edwardsville.

The figures of production are as follows:

	1914	1913
Truesdale	1,152,201	1,089,510
Prospect	1,097,973	1,110,554
Woodward	1,053,461	881,119

Ethane, C_2H_6, is of the paraffin, or marsh gas, series. It contains 79.96 per cent. carbon and 20.04 per cent. hydrogen by weight. It contains, when pure, 1,728 B. T. U. per cubic foot. It is found in considerable quantities in natural gas associated with methane belonging to the same series. It is liquified at 696.2 pounds pressure and boils at −93° C. under 700 m. m. pressure. It is not found in mine gas as a rule.

Mine Gases

Discussions on Mr. Haas' Paper Read Before the West Virginia Mining Institute and Printed in the February COLLIERY ENGINEER

Abstracted for The Colliery Engineer

The discussion of Mr. Haas' paper was quite extended, and it is hoped that others will give their views on this interesting and important subject. It was as follows:

Dr. I. C. White, Morgantown, W. Va.: It is certainly a very able paper which Mr. Haas has read. He calls attention to many things which I have observed in the study of natural gas that tend to support his view that a large part of the gases found in coal may possibly have had their origin in the deep-seated strata. I remember one well that was drilled near Hundred, in Wetzel County, W. Va., where enough gas was found in the coal to run the drill, finish the well through the Gordon sand, supply the town of Hundred with gas for many years, and probably is still furnishing some gas for consumption.

We can hardly conceive of such a supply of gas to last a year coming from coal alone. I can say that later a great gas field was developed near Hundred, 2,000 feet below the coal. Several gas producing sands having very high pressure underlie that region. Then, too, the fact that gas will come from underlying beds up into higher ones was demonstrated by the history of a well in either Lewis or Harrison County. Gas was found at about the horizon of the Berea sand and the gas pressure was much higher at the top, although it is said to increase in depth in about the same proportion as a column of water increases. One hundred feet of water is supposed to create a pressure of about 45 pounds to the square inch. Professor Sinton demonstrated this at Findlay, Ohio, where he measured the gas wells, calculated the pressure, and found it corresponded with gauge pressure in many instances. In this particular well the gas pressure was 200 or 300 pounds greater than its depth would warrant. It was in a faulted region and it is presumed that the Berea sand had been gradually fed gas by deeper sands, which had a pressure of from 900 to 1,000 pounds to the square inch. In this particular well the gas which escaped from the lower strata through the fissures could not escape from the Berea sand to the surface so fast as received. In the same way, since all strata have fissures, the immense gas pressure, which sometimes is 1,500 pounds per square inch in the deep-seated sands, might force the gas up into any porous strata like coal. The theory that gas increases in pressure with depth has also been demonstrated in the second deepest well in the world, that near McDonald, Washington County, Pa., which has reached a depth of 7,070 feet (the well at Czuchow, Upper Silesia, the deepest in the world, has a depth of 7,380 feet). Mr. Pugh, who has charge of the well near McDonald, says that if nothing happens he will make it the deepest in the world, 8,000 feet. Mr. Pugh, who is the head of the Peoples Natural Gas Co. (one of the Standard Oil Co.'s affiliated corporations), conceived the idea of drilling in this favorable locality down into the underlying sands. After drilling to between 5,000 and 6,000 feet in depth, beds were found which contained deposits of carbon, and also pockets of gas were found with such enormous pressure that they would throw the drill several feet up the hole and cause considerable trouble until a way was found to prevent it. The flow of the gas will come with a noise like a railroad train so the drillers know from the sound that the gas is under much greater pressure than when found at ordinary depths—possibly 2,000 or 3,000 pounds to the square inch. Everywhere these imprisoned gases are under enormous pressure and there is no reason why they should not escape to the surface through small fissures. So far as we know about natural gas, it would confirm Mr. Haas' idea with reference to the origin of a considerable portion of the gas in mines. In the mountain towns of Pennsylvania, in Tioga County, where holes have been drilled from 3,000 to 4,000 feet, little gas is found, which would also confirm Mr. Haas' idea."

Mr. Paul: The statement made by Mr. Haas in regard to the possible source of gas in coal mines seems probable. However, there is one feature in connection with the matter about which I would like information. In the analyses of gas from many coal mines of this country, it has been found that the principal ingredient is methane; but occasionally there have been found samples which contained some ethane. In one of the mines with which Mr. Haas is familiar a high percentage of ethane was found. Natural gas throughout a large part of the country yields a large percentage of ethane. The Pittsburg gas, which is piped from West Virginia, has about 13 per cent. ethane to about 87 per cent. methane. In some mines in which samples were taken doubts have arisen as to whether the gas originated where found or came from some natural gas reservoir.

Furthermore, ethane does not appear in the gases normally found in coal mines in this country although some claim that they have found ethane in every mine gas.

The question I wish to ask is how does Mr. Haas account for the absence of the ethane in the inflammable gases usually found in coal mines if the source of supply of the gas which is found in the porous structure of the coal comes from a source other than the coal itself?

Mr. Haas: That is a pretty difficult question to answer and I don't think I can answer it, but I may be able to explain why. The test for ethane is very difficult. You may

take the textbooks and they will tell you what to do, but it is an approximation at best. The Bureau of Mines has probably done the best work along this line. The first thing the members found was that it was very difficult to analyze gas. The next difficulty was to find a mine with sufficient inflammable gas to make an analysis. For instance, if, as Mr. Paul says, ethane is perhaps one-eighth part to one part methane, you can get a sample that runs only about 5 or 6 per cent. total, and it would be very difficult, indeed, to determine whether it was ethane or methane. Another reason is that the gas is impure. In experimenting, that would account for the absence of ethane in mine gases. Whether that is the case or not, I do not know, but it is a theory.

We know that ethane is not nearly so stable a gas as methane. It is just possible that ethane is eliminated from the real mine gas in its meanderings from 2,000 to 3,000 feet below the surface, through the different stratifications and different mineral waters, and does not reach the coal. Mr. Paul's ultimate view is correct. We have found out in our investigations, crude as they have been, that ethane is not present to any appreciable extent in any of the so-called "firedamp."

Edwin M. Chance: I have listened with interest to Mr. Haas' very able paper but there are considerations embodied in that paper with which I am not in full accord.

In the first place, much confusion has arisen in the past and still obtains in the consideration of blackdamp, due to the belief that blackdamp was not the same as carbon dioxide but still intimately associated with it: that blackdamp owed many, if not all, of its properties to carbon dioxide. This is not the fact. We have made many hundreds of analyses of blackdamps (I am speaking, of course, of gases having their origin in the anthracite region) and I would say that, while my experiments with mine airs from bituminous mines is limited, still the very excellent and very able work of the Bureau of Mines leads me to believe that very much the same conditions obtain in the bituminous regions in regard to blackdamp that obtain in the anthracite.

We have made many hundreds of experiments by sealing off the mines and analyzing the air daily, selecting sections well provided with bore holes, so that uniform samples could be had and many of them could be secured. We found, of course, that the oxygen in the air disappeared very rapidly. We found that in the course of a few days it reached a percentage of less than 1 and that most of that oxygen, equivalent to about 20 per cent. had been fixed. Now, under the ordinary conception, we would expect to find some 15 or 16 per cent. of carbon dioxide; instead, however, we find generally in the neighborhood of 4 or 5 per cent. In fact we have developed a method for determining whether blackdamp has been the product of combustion or is the product of slow oxidation, by calculating the percentage of carbon dioxide in the blackdamp. We have found, in considering the percentages of carbon dioxide in the blackdamp, that where fires are present the carbon dioxide of the blackdamp will be in the neighborhood of 15; and where no fires are present the percentage will be from 3 to 4, up to about 8 per cent. This low percentage of carbon dioxide is dependent, to my mind, on the fact that oxygen is fixed by coal at ordinary temperatures without the liberation of anything like the normal percentage of carbon dioxide.

Now, the respiratory phenomena of asphyxiation are caused, not by deficient oxygen, but by carbon dioxide. In an atmosphere containing 10 per cent. oxygen, with little carbon dioxide, say one-tenth of 1 per cent., men will show no marked distress, and will even show little marked distress when the oxygen percentage is so low that unconsciousness intervenes. In an atmosphere containing a normal percentage of oxygen, but with 4 or 5 per cent. of carbon dioxide, they will suffer severe pains, distress, blueness of the veins, etc. The reason for this is that the respiratory organs are controlled by the resistance of the respiratory centers to carbon dioxide in the lung cells and not by the percentage of oxygen.

I have made these few remarks in order to bring up the fact that in an atmosphere containing 10 per cent., or even 9 per cent. or 8 per cent. or so, of oxygen, a little carbon dioxide can be borne without distress and that a person can work in comfort if too much work is not done. For that reason the oil lamp is the most unsatisfactory indicator of the quality of the air. I know of many cases of atmospheres, not produced by fire, in which men could work and did work when the occasion required, where the oil lamp was at once extinguished. To my mind the most valuable indicator of the quality of mine air is the acetylene lamp. The acetylene flame becomes bluish and is extinguished with 12 per cent. oxygen in the atmosphere, thus giving a margin which, under the conditions I am discussing, is ample for safety, and still permits the miner in case of need or abnormal requirements to do work. Understand, I am not recommending for one instant the habitual performance of work in an atmosphere that extinguishes an oil lamp, but cases arise when it is necessary to make an investigation or examination in atmospheres extinctive to an oil lamp, and under these conditions the acetylene lamp is the most valuable guide.

Another consideration: Mr. Haas made the statement that carbon monoxide is never produced by the direct combustion of carbon with oxygen. This statement, I am sorry to say, is a little loose. At a temperature of and above 1,200° C., carbon dioxide is disassociated into carbon monoxide and carbon dioxide. It has been well established and has been ably set forth by Nicloux (Comptes Rend. 157, 1425–1913) that the effects of carbon monoxide are not cumulative; that at every partial pressure of carbon monoxide and oxygen there is a

corresponding definite and fixed saturation of hemoglobin. If the blood of an animal is exposed to an atmosphere containing a minute but uniform percentage of carbon monoxide, say .01 per cent., that animal's blood will after a time reach a certain saturation with carbon monoxide which will remain fixed and will not be altered later unless either the oxygen or the carbon monoxide content is changed. This saturation point is reached when the partial pressure of the carbon monoxide in combination with the hemoglobin is equivalent to the partial pressure of the carbon monoxide in the air. By a formula, given the oxygen concentration and the carbon monoxide concentration, the saturation of the hemoglobin can be most accurately calculated. I would say in connection with this that the saturation of hemoglobin is the direct cause of the ill effects of carbon monoxide poison, and that with a saturation of 50 per cent. great distress is experienced, while with the saturation increased to 80 per cent. death will supervene.

Mr. Paul's remarks are in direct line with the facts. It is my belief that it is considered the best modern practice now to administer a mixture of oxygen and carbon dioxide in anesthesia. When a small quantity of carbon dioxide is administered with oxygen the breathing is much deeper and therefore the oxygen has better effect and opportunity to work.

I think that perhaps Mr. Beard misunderstood the statement that I attempted to make with reference to the effect of carbon dioxide. The effect of carbon dioxide is largely incident to the oxygen. As Mr. Paul stated, if we increase the content fivefold, or practically fivefold, by administering pure oxygen, it will have a great effect upon the respiratory organs, because the percentage of the carbon dioxide in the lung cells is just as high when 7 per cent. is breathed with pure oxygen as with normal air. We do not usually in the absence of fire, have percentages of carbon dioxide high enough to be extremely distressing unless the oxygen content is automatically so lowered as to cause grave danger from a deficiency of oxygen. With a blackdamp containing, say of 8 per cent. of carbon dioxide, if the normal air shows 4 per cent., then the oxygen must be 10 per cent. With 10 per cent. of oxygen the effects produced will be more dangerous from the deficiency in oxygen than from the 4 per cent. carbon dioxide. In fact, the 4 per cent. will prolong life by creating deeper and more frequent respiration. To repeat: in breathing atmospheres containing 2 per cent. or 3 per cent. carbon dioxide and, we will say, 10 per cent. or 12 per cent. oxygen, the respiration will be better and the man will be more resistant to the gas than if he breathes that air without the carbon dioxide.

Dr. I. C. White: The natural gas found at Mercersville, Pa., was practically all methane and had no odor. In one of the great natural gas fields in Canada, the wells, I understand, produce nearly all methane. All the higher hydrocarbons being practically absent. This being the case there is a great natural gas field in which ethane and the higher hydrocarbons out of which gasoline is manufactured are absent.

We must also remember that methane is one of our most permanent gases and it requires enormous pressure to reduce it to the liquid form, while ethane and some other hydrocarbons require only limited pressures. Is it not possible that ethane remains in a liquid condition in these underlying rocks where the pressures vary from 800 to 1,000 pounds to the square inch, while methane, which cannot be changed into a liquid condition with any pressure that has ever been put on it, would be the only gas that would leak into the coal mine? Undoubtedly there would remain some methane in the coal beds from the carbonization of the vegetation. Where gas is under such great rock pressure, it seems natural to conclude that some of it may come up into the coal beds. If these gases do come up from the strata below the coal mine, as they seem to do in all regions where there is natural gas, the absence of ethane would be accounted for by the theory that it remains in liquid form below and has no chance to rise.

Professor Zern: I believe Doctor Haldane is the generally accepted authority on mine gases in England. In his book, entitled "The Investigation of Mine Air," published in 1905, he makes the statement that up to that time none of the higher hydrocarbons had ever been detected with certainty in numerous examinations of gas from blowers.

On December 19, 1910, an explosion occurred in the Meadowbrook mine, of the Consolidation Coal Co., a mine where no explosive gases had ever been found. An investigation showed the likelihood of the gas having come from a gas well near by. This was later definitely accepted as correct, upon the statement of an expert chemist that a sample of the mine air showed large quantities of ethane. I merely mention these two incidents to show the general impression that ethane and methane are not found together in mine gas.

As you are no doubt aware, the Alaska coals are considerably faulted and broken by folds. Mr. Samson Smith, the Federal inspector, recently made the statement that at many places one can find gas in the soft crumbly coals, not over 60 feet from the outcrop. It is very evident in this case that the gas does not come from the lower formations. In order that I may the better understand, I wish to ask Mr. Haas whether his statement is that the gas comes only from below, or whether there are two possibilities: first, that some of the gas may have its origin in the coal; second, that some of it may come from the strata below?

Mr. Haas: I might as well go the whole road and say this: we have some mines that produce no appreciable amount of gas. You

can get it down to $\frac{1}{100}$ of 1 per cent. This will be true of the mine for a period of a year's time. Then there is a mine within a very short distance of it and I am afraid to tell you how much gas it has.

MR. BEARD: I think we are liable to a misunderstanding through some of the terms that have been used. For instance, in speaking of ethane, C_2H_6. Professor Zern has just drawn attention to the remarks of J. S. Haldane, of England, who says that seldom, if ever, is ethane found in coal. That is true, but I think from the reference to this gentleman, that some of the speakers have been referring to ethene. Ethene, as we know, is the non-hydrocarbon of methane, in the matter of higher hydrogen percentage. There are two qualifications there, the methane CH_4, and the ethane C_2H_6, belonging to the one class, and the ethene C_2H_4, which belongs to another. If I am right, this should be clearly brought out in this discussion and we should not use those terms indiscriminately.

I did not expect to take any part in this discussion, but it has been very interesting and it would be presumptuous of me to attempt to criticise Mr. Haas' paper, although there are a number of his statements with which I would have to take issue.

I have for many years made a close study of the theory of gases in mines in connection with their actual appearance in the mines as we find them, and have taken my lamp along and have made a very close study of every principle in the mine.

Mr. Haas has made some statements in reference to the effect of carbon monoxide gas. If I understand him rightly, he spoke about there very seldom being any percentage of carbon monoxide in the the mine that would be at all dangerous, or, perhaps, that we need guard against. The conditions are so various in regard to the occurrence of gases, as I have come in contact with them, that we cannot lay down these theoretical rules as absolute rules. They have a great importance in the theoretical study of the subject. There is no question about that. This matter of percentages is very important when we approach a subject, studying it for technical purposes and for investigation, and, as Mr. Haas has said, the matter of percentage of gas is of very little importance to the miner in his work, as you know. One may obtain a lamp full of flame in one part of an entry while another at the same time may obtain little flame in a different part. The gas travels in streaks in that way. I have one case in mind where the fire boss who was with me told me to tarry a moment and he would go to the face. He went, and while there examined for gas and found none. Then he allowed me to go to the face, and I had a lamp full of flame in a few moments. Of course that is easily explained, as his movements disturbed the atmosphere so that when I got there I had plenty of gas in my lamp.

There was another statement that "it is of little importance where the gas comes from inasmuch as it exists." I do not know if any of us understand fully the importance of these conditions as they exist in the mine. We study the subject from a minute technical point of view. For instance, take the matter of coal dust. The statement was made that there is no carbon monoxide present sufficient to perhaps even be indicated on the lamp. In the close measurement of percentages, as found in mine air, that statement is hardly correct. Formerly, in one mine, I was able to find 2 per cent. of gas in a room. The men were loading coal and I had them stop a few moments, then I lowered my lamp into the dust at the floor where they had been loading and immediately got $2\frac{1}{2}$ per cent. The difference was due to the dust burning in the flame of the lamp, which I presume produced sufficient carbon monoxide in addition to the methane to increase the percentage shown." It is questionable whether it was methane or whether it was carbon monoxide in the air that produced the dangerous condition. In this case I mention, one would naturally expect to have the highest percentage of gas in the room where the accumulation undoubtedly is, but below, where this was, the indication was increased about $\frac{1}{2}$ per cent.

I suppose very few men have been quietly looking into the matter of gas for a longer period than I have. I like to study a subject patiently: I do not believe in giving out statements too much beforehand, because I consider the conditions so variable that we are liable to make statements that are incorrect and misleading. For very many years I was busy on one particular phase of mine gas before I dared to put out anything much in the way of a publication, and yet even the statements I published at that time have been ridiculed by those who have studied less, perhaps; but, as one of our speakers said, they put out a publication and they rather disregard the statements that have been proven by those who have given a life study to the matter.

Take the statement that the combustion of methane would not produce carbon dioxide. That, according to J. S. Haldane, who is one of our highest authorities on the subject, is untrue, because you decrease the quantity of the atmosphere: in the combustion of methane you increase the quantity of carbon monoxide and the percentage of carbon monoxide in the deficiency of oxygen increases until it becomes dangerous.

It has been stated that if a gasoline motor was properly equipped, in good condition and properly operated, it would not produce a dangerous gas. One man even said: "Talk about this gas being dangerous, why you cannot even smell it." You know they have deodorous gas now. Another man said: "It is all the more dangerous if you can't smell it because you don't know of its presence." But the real danger, to my notion, comes from the numerous chances for a defective carburetor producing a considerable

percentage of carbon monoxide. In case the locomotive happened to be in an entry where there was not sufficient ventilation, or, if, for any reason, it started up after standing, there would be a dangerous percentage of this gas. With reference to an accumulation of gas at the floor, I believe the temperature has more to do with that than the specific gravity of the air. In cases of dangerous gases, sometimes, instead of finding them at the roof, we find them at the floor. I have often been asked to explain that condition. There are mixtures of these gases that it would be well for us to study more carefully. I think that we ought to be very careful as to our statements in this regard and we ought to go slow about making these statements instead of giving them out off-hand, so to speak. For my part, I have such a poor memory on percentages that I would not even dare to state what would be a dangerous percentage of carbon dioxide, but I think it depends very largely, and in saying this I may contradict a previous statement made here, on the quantity of oxygen present. There is no question about that. That is a fact well established by men who have given a life study to the question. The statement that was made ought to be corrected. We ought not to make those statements because the lungs and maintenance of life do depend on the quantity of oxygen and carbon dioxide, although a non-poisonous gas becomes suddenly dangerous when there is a depreciation of oxygen in the air.

Mr. Haas: I would like to ask Mr. Paul what he thinks on the cumulative action of carbon monoxide.

Mr. Paul: Mr. Chance has refuted to a large extent the instances of the authorities in the matter of the cumulative effect of carbon monoxide.

It has been found by experiments that the effect depends largely upon the poisoned gases during the time they are being inhaled. It is found that some animals will become immune, to a certain extent, after being subjected to the effect of the carbon monoxide for a long period of time. As an illustration, a guinea pig or a rabbit may be subjected to carbon monoxide percentage cumulative for a number of days and thrive upon the increased percentage of the carbon monoxide, whereas, if you were to introduce a fresh guinea pig or rabbit into the same atmosphere it would almost immediately die. We have that on record as a result of experiments made with a view of determining the cumulative effect of carbon monoxide. It is believed, however, that persons die from what might be called a progressive cumulative action on the hemoglobin of the blood, decreasing saturation without the man's knowledge until such a time as he is unable to get sufficient oxygen to support himself. It is the consensus of opinion that the carbon monoxide merely deprives the blood of its capacity to absorb oxygen by depriving the hemoglobin of its ability to take up oxygen. It is claimed by some that it has a poisonous effect, but, in reality, it is the deprivation of the blood of sufficient oxygen. While speaking on that, I want to make sure that I understood Professor Beard to say that he detected 2 per cent. of carbon monoxide with a safety lamp?

Mr. Beard: I simply referred to an explosive condition. I did not attempt to say that it was carbon monoxide.

Mr. Paul: We have found in our investigations and tests that carbon dioxide governs very largely the ability of a man to thrive in any kind of atmosphere. We have found that when a man is breathing almost pure oxygen, and the percentage of carbon dioxide goes up to 7 or 8 per cent. the man becomes rather insensible. It is a different percentage with different men. We have had men breathe air and become unconscious and limp when the carbon dioxide reached 9 or 10 per cent., but the majority of the men breathed as high percentages of oxygen as when the carbon dioxide amounted to 7 per cent., and the carbon dioxide is apparently one of the stimulating qualities of respiration. As you all know, to revive babies that are born who are not able to respire, they will blow into the mouths, not for the purpose of starting up respiration, but to get carbon dioxide into the lungs to stimulate the respiratory center and bring on natural respiration.

Mr. Chance: Mr. Paul's remarks are in direct line with the facts. It is my belief that it is considered the best modern practice now to administer a mixture of oxygen and carbon dioxide in anesthesia. When a small quantity of carbon dioxide is administered with oxygen the breathing is much deeper and therefore the oxygen has a better effect and opportunity to work.

I think that perhaps Mr. Beard misunderstood the statement that I attempted to make with reference to the effect of carbon dioxide. The effect of carbon dioxide is largely incident to the oxygen. As Mr. Paul stated, if we increase the contents fivefold, or practically fivefold, by administering pure oxygen, it will have a great effect upon the respiratory organs, because the percentage of the carbon dioxide in the lung cells is just as high when 7 per cent. is breathed with pure oxygen as with normal air. We do not, usually in the absence of fire, have percentages of carbon dioxide high enough to be extremely distressing unless the oxygen content is automatically so lowered as to cause grave danger from a deficiency of oxygen. With a blackdamp containing, say 8 per cent. of carbon dioxide, if the normal air shows 4 per cent., then the oxygen must be 10 per cent. With 10 per cent. of oxygen the effects produced will be more dangerous from the deficiency in oxygen than from the 4 per cent. carbon dioxide. In fact, the 4 per cent. will prolong life by creating deeper and more frequent respiration. To repeat: in breathing atmospheres containing 2 per cent. or 3 per cent. carbon dioxide and,

we will say, 10 per cent. or 12 per cent. oxygen, the respiration will be better and the man will be more resistant to the gas than if he breathes that air without the carbon dioxide.

Mr. Virgin: Is it not a fact that when we get this so-called black-damp it is not so much carbon dioxide as it is free nitrogen that causes us so much trouble?

Mr. Haas: I think the question was whether it was nitrogen instead of carbon dioxide. I would say this: that what we know as black-damp and what we experience as blackdamp is mostly nitrogen. The carbon dioxide is rather infrequent as found in the mines.

Fireproofing Mine Shafts

The state of Illinois demands that all coal mine shafts shall be made fireproof. Although much has been written about fireproofing and durable linings for mine shafts, a further contribution to the existing literature and data will not be without value.

The two general phases to be considered are: First, the problem of lining a new shaft not yet sunk, and second, the problem of replacing or protecting a shaft lining already in place in an operating mine so as to make it fireproof and durable.

Where a new shaft is to be sunk, the engineer has to study the nature of the strata to be penetrated and then select from among several excellent designs that have been tested that one which the exigencies of the case and financial limitations may prove to be best, all things considered.

For excellent design of poured concrete lining of shafts the reader is referred to F. A. Allard's articles in Mines and Minerals, April, 1910; October, 1911; October, 1912. Also the article by E. R. Jones in the September, 1912, issue, "Lining the Loomis Shaft," in the July, 1912, issue, and to the description of a method of using steel and concrete in lining a shaft, as designed by Mr. Carl Scholz, which appeared in The Colliery Engineer, August, 1913.

A new shaft at Sesser, Ill., is being lined with premolded beams and slabs, made complete at a factory in Indiana and shipped to the mine to be lowered and secured in place like so much timber. A description of a somewhat similar operation may be found in the *Engineering Record*, of October 31, 1914.

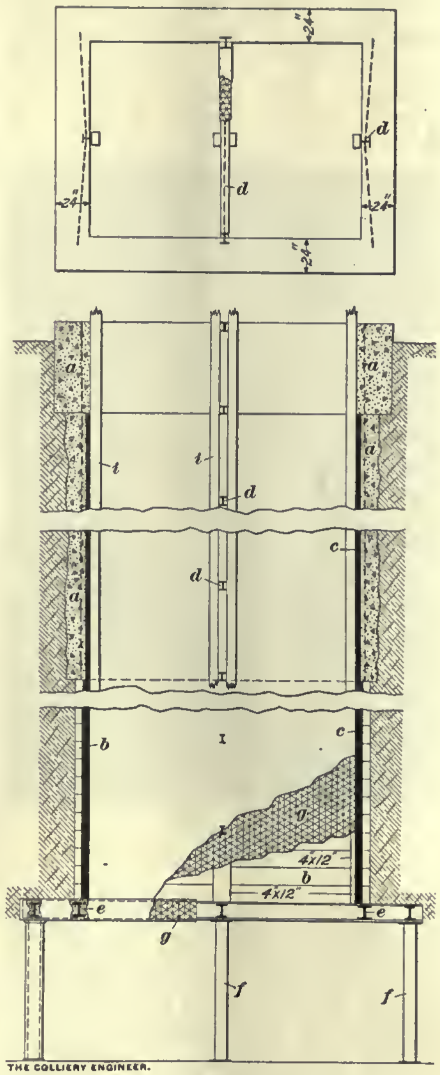


Fig. 1

The purpose of this paper is to show a method of lining a mine shaft with cement grout. This may be applied to a new mine just being sunk, or to protecting a mine that may have been timbered and which it is desired to protect against fire and decay, or corrosion.

The mixture is usually one part Portland cement to three parts of sand. When this is "shot" with an air pressure of about 35 pounds per square inch by means of the Cement Gun, the resulting product adheres very tenaciously to the surface of application, be it stone, wood, or steel. The grout is dense, being 23 per cent. heavier than a 1–2–4 concrete and tests show it to be impervious, non-absorbent, and with a much higher tensile and compressive strength than high-grade concrete. A 2-inch layer is considered a safe fire and rust protection for steel work in sky-scraper construction subjected to a 4-hour exposure of 1,700° F. A 1½-inch layer will indefinitely protect steel buntons or sets against corrosion and will protect wood and steel against any fire that may occur.

Fig. 1 shows a shaft in which solid poured concrete *a* is used down to the rock. From the rock down to the bottom the ordinary skin lining *b* of 4″ × 12″ wooden plank is used. In this, depending upon the pressure encountered, the lining may be placed on edge or cribbed.

The wood lining is shown with a 2-inch layer of reinforced grout *c*, which will protect the wood against fire and will seal off all water and air, making a shaft that is dry as well as fireproof. The water-logged timber behind the grout will never decay or need repair.

Of course, where free water exists behind the lining it must be taken care of to relieve the hydrostatic pressure.

By applying a coating of grout to the surface of the concrete lining all irregularities and defects can be corrected and that part of the shaft made dry.

In the case of a new shaft with new timbers, this grouting insures durability as well as making it fireproof. Since decay requires the presence of moisture, warmth, and air, the exclusion of air will make these timbers proof against decay. This method has an advantage in that sinking and timbering may be pursued in the usual way, and the grout applied at night after the shaft is completed and in use in the day time.

In the illustrations 5-inch H beam buntons *d*, 10-inch H side plates *e*, and 8-inch round cast-iron columns *f* are encased in cement grout to protect them. Timber lining could be protected in the same way.

In the case of old shafts, if decay has not already made damaging progress, the shaft can be made fireproof and the timber secured against further decay by this method.

While the illustration shows the shaft timbered throughout, there are many cases where the lining may be omitted entirely through the rock strata by sinking and trimming close to dimensions and sealing up the strata with a layer of grout applied before the air has disintegrated the rock. In this case the grout is shot into every crack and crevice of the rock and not only covers the surface but cements the rock.

In mines where it is necessary to use heavy sets, either of wood or steel, with lagging on the outside, the entire surface may be protected with reinforced cement grout. This method was employed in lining the Cary shaft of the Odanah Iron Co., Hurley, Wis. The work was done by the Cement Gun Construction Co. under the direction of L. M. Hardenburgh, general superintendent. In this case the three-compartment shaft was lined with 3-inch wood plank carried by I beam sets. The lagging and beams were covered with 2 inches of reinforced "gunite," or cement grout. The shaft was so wet that the men had to work in slickers, however the part lined with gunite is now perfectly dry.

The matter of costs of the different concrete shaft lining methods varies and depends on the cost of material, etc. The method of using premolded members may be advantageous where the factory is near a gravel pit.

In Fig. 2 is shown a method of forming a partition between the hoisting and air compartments of a shaft. The buntons *d* are coated with cement grout, then triangular mesh wire cloth *g* is fastened to 1-inch boards *h*, after which 1 inch of cement grout is blown on them. When this has set, the boards are removed and 1 inch of cement grout substituted. The method of fastening the guides *i* to the buntons is also shown in this figure.

The method of sinking and lining with timber as heretofore followed

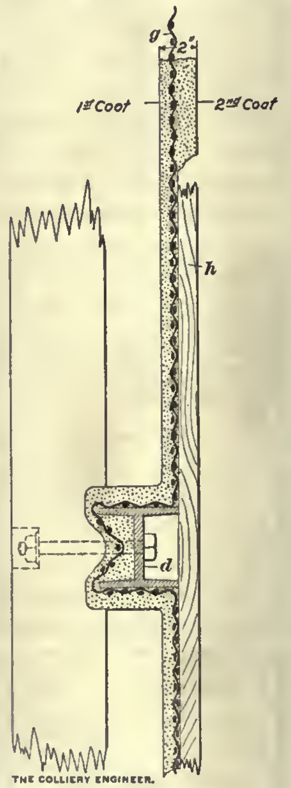


Fig. 2

will be continued very largely in the future and except in a few isolated cases this method of lining and encasing the timber in grout will be found to be least expensive.

One great advantage claimed for the method is that it can be applied at relatively small cost to mines either old or new and without seriously interfering with the operation of the mine.

PERSONALS

Joseph B. Garner, of Asland, Pa., division engineer for the Philadelphia & Reading Coal and Iron Co., has been promoted to the position of division superintendent of Shenandoah Division with headquarters at Shenandoah, Pa. The Shenandoah Division is a new division made by dividing the old Ashland-Gilberton-Shenandoah Division, which since its formation was under the superintendency of Adam Boyd. Mr. Boyd will continue as division superintendent with headquarters at Ashland.

A. C. Vicary, of Lorain, Ohio, has been made sales manager of Steam Shovel Department of the Ball Engine Co. The company is now placing a line of revolving shovels on the market under the name of the "Erie Steam Shovels."

W. D. Monsarrat, formerly general manager of the Sunday Creek Coal Co., has opened a consulting engineering office in the Hardman Building, Chicago.

John J. Penhale, the well-known asbestos expert, of Sherbrooke, Canada, has been appointed colonel of a Canadian regiment and is now with the expeditionary force in England.

The Board of Regents of the University of Nevada announces the election of Archer Wilmot Hendrick, A. M., as president of the University. The election took place on September 9.

Frank H. Bender, chief transitman of the Mahanoy Division of the Philadelphia & Reading Coal and Iron Co., has been promoted to the position of Division Engineer of the Shenandoah Division, vice Joseph B. Garner promoted to the division superintendency. Mr. Bender is succeeded by John B. Pierson.

G. D. Tinsman has been elected president of the Cochran Coal Co. and the Kettle Creek Coal Co., succeeding the late George L. Miller. The latter's son, W. H. Miller, has been appointed general manager of the Kettle Creek Co.'s mines at Bitumen, Pa.

Willis Meade, division engineer for the Dodson Coal Co., at Morea, Pa., has tendered his resignation to take effect February 15.

W. B. Williams has resigned his position as general superintendent of the Utah Fuel Co., at Castle Gate, Utah.

Mayor Z. P. Mortimer, of Pottsville, Pa., has named W. J. Richards, president of the Philadelphia & Reading Coal and Iron Co., as one

of a commission of five, which will be known as a "Planning Commission."

The Court of Common Pleas of Luzerne County, Pa., has appointed the following as members of the mine inspectors' examining board: E. R. Pettebone, chief engineer of Delaware & Hudson Coal Co.; A. B. Jessup, general manager of G. B. Markle Co.; John J. Hanlon, of Avoca; Patrick Dougherty, of Lansford; and Daniel B. Bolton, of Nanticoke.

Guy E. Marion, secretary-treasurer of the Special Libraries Association, has severed his connection with the Arthur D. Little Co., of Boston, Mass., after being five years in charge of its Information Department. Mr. Marion will devote his time to the organization and development of Special Libraries, or Information Departments in business houses, industrial plants, etc.

Geo. D. Evans, mining engineer, of Pottsville, Pa., has accepted a position in charge of the operations of the Beaver Valley Coal Co., at Beaver Valley, Columbia County, Pa., and can be addressed at that post office.

Owing to the war in Europe, the Nova Scotia Mining Society will not hold their annual meeting in March, 1915.

Deserved Promotions

Walter H. Clingerman, for a number of years general superintendent of the H. C. Frick Coke Co., was elected president of that corporation on January 18 to succeed the late Thomas Lynch.

Mr. Clingerman is in the prime of life, being 46 years old, though in appearance, vitality, and activity he appears even younger than his years. He started in his career as an apprentice in the Pennsylvania Railroad Co.'s machine shops in Altoona in 1885, immediately after passing through the public schools of that city. In 1889 he was transferred to the office of the superintendent of motive power, as draftsman and in charge of construction work. In 1895, by special arrangement, he temporarily left the employ of the Pennsylvania Railroad Co. to superintend the construction of the car shops of the H. C. Frick Coke Co., at Everson, Pa., and he inaugurated, at those shops, the system of making car repairs on a piece-work basis. Early in 1896 he returned to the employ of the

Walter H. Clingerman
President H. C. Frick Coke Co.

Pennsylvania Railroad Co. In September, 1897, he accepted the position of general foreman of the car shops at Everson, whose construction he had superintended, and in 1898 he was promoted to the position of assistant general superintendent of the H. C. Frick Coke Co. On the resignation of the late O. W. Kennedy as general superindent, in February, 1904, Mr. Clingerman became general superintendent. During the nearly 15 years that he filled this position he showed such ability and judgment that the late Thomas Lynch as president of the company, and a man of superior judgment and executive force, placed the utmost confidence in Mr. Clingerman and delegated to him greater power and authority than had ever been given any of his predecessors except Mr. Lynch himself. His selection as president of the company was the natural result of his years of successful management, and was a well-deserved promotion.

Mr. Clingerman has been succeeded as general superintendent by Clay F. Lynch, a son of the late president. Mr. Lynch has also been made vice-president of the company.

Mr. Lynch is a young man, being but 35 years of age, but he is well equipped through training and successful managerial experience for his new position. On attaining his majority in 1901 he entered the service of the H. C. Frick Coke Co., and in the 8 years from that time until 1909, he rendered such service and showed such ability that he was appointed general superintendent of the Bunsen Coal Co., of Illinois, whose extensive and up-to-date mines (described and illustrated in The Colliery Engineer for October, 1911, and October, 1912) were opened and developed under his supervision. Mr. Lynch brings to his more important position the energy and force of a young and active physique, supplemented by a well-trained mind. He will, undoubtedly prove a worthy successor to his late father, and his more immediate predecessor, Mr. Clingerman.

Mr. Thomas Moses, formerly superintendent of the Westville mines of the Bunsen Coal Co., has been promoted to the general superintendency of the Bunsen Coal Co., in place of Mr. Lynch.

That noise doesn't denote efficiency is exemplified in appliances for forced draft under steam boilers. Blowers of the steam-jet type make more noise, use more steam, and are much lower in efficiency than blowers of the turbine-driven fan type. The latter move silently and accomplish results. They have so thoroughly proved superior merit that a number of the larger anthracite mining companies that use the smaller sizes of coal, or culm, for fuel, are using them.

WITH THE EDITORS

Notice

WITH the publication of this number, Mr. Eugene B. Wilson retires as editor of THE COLLIERY ENGINEER to accept a position as head of another department of the business conducted by the publishers. While Mr. Wilson retires from the editorship, his connection with this journal is by no means severed, as he will continue to be a contributing editor, and will as occasion may require act in a consulting and advisory capacity to the editorial force.

Mr. C. M. Young, E. M., a mining engineer of broad education and experience in many coal fields, and a gentleman whose contributions to various technical journals and the proceedings of various technical societies have always excited favorable comment, succeeds Mr. Wilson as editor.

RUFUS J. FOSTER
Managing Editor

The retiring editor of THE COLLIERY ENGINEER wishes to thank the many writers who have contributed toward making it a highly successful technical journal. He trusts that both writers and patrons will accord Mr. C. M. Young, the new editor, the same kindly considerations as they have the retiring editor.

AS AN instance of the neutrality existing between the United States and England it is authoritatively stated that T. A. Rickard, editor of *The Mining Magazine*, London, England, and H. Foster Bain, of the *Mining Press*, San Francisco, U. S. A., will exchange places for a few months.

Mine Workers and "Booze"

AS A class there is no more drunkenness among coal mine workers than there is among similar labor in any other American industry. Naturally, among the hundreds and often thousands of mine workers in mining communities, there are some hard drinkers. These, however, comprise but a small percentage of the whole; but this small percentage of a large class seems a number of considerable size, if the total number of mine workers is not kept in sight. For instance, it is assumed that in a machine shop, or other industrial plant, employing one hundred men, 5 per cent. are hard drinkers, that means only five men are so classed. In a mining community the same percentage of one thousand mine workers, means fifty men; of two thousand, one hundred men; and of five thousand, two hundred and fifty men.

It makes no difference what the actual percentage may be, there is no industry employing large numbers of men having a smaller percentage of hard drinkers than the coal mining industry.

In a recent letter to the writer, Col. R. A. Phillips, general manager of the Coal Mining Department of the Delaware, Lackawanna & Western Railroad Co., a man who rose from the ranks to his present position, said:

"I have lived and associated with the D., L. & W. miners all the days of my life—no one knows their habits and mode of living better than I.

"I know of no people with a higher standard of sobriety, morality, and American manhood and good citizenship, than the mine employes."

In making this statement, Colonel Phillips referred to the mine employes as a class. He knows, as does every man familiar with life in coal mining regions, that while as a *whole* the mine workers are entitled to the above commendation, there are among the large number a comparative few who use liquor to excess.

Colonel Phillips' statement will apply to practically every coal field. The statement we make regarding the "comparative few who use liquor to excess" also applies to every coal field.

The mine laws of all states provide that intoxicated men shall not be allowed to enter the mine. That this is a wise provision cannot be controverted. In states where both miners and operators influenced the nature of the laws, no matter how widely they differed on other sections, they both strenuously supported the exclusion of drunken men from coal mines.

Unfortunately, however, the laws that are intended to keep drunken men out of the mines, do not provide a formula by means of which drunkenness can invariably be detected. A man may drink considerable liquor within a few minutes before he presents himself at the mine opening and show no outward sign of intoxication, and within half an hour or an hour after entering the mine be recklessly drunk. Such a man not only jeopardizes his own safety, but is a menace to the safety of every other man in the mine. One drunken man in some coal mines may commit some foolishness that will bring death or serious injury to several hundred of his fellow workmen.

With a view to prevent a drunken man entering the mine, the officials of the Coal Department of the Delaware, Lackawanna & Western Railroad recently started a movement to have all bars in the vicinity of their

mines kept closed between the hours of 11 P. M. and 7 A. M. That is, the bars would not be open until all the men had entered the mine, and would be closed at a reasonable hour at night so that in case a mine worker did overindulge at night he would have time enough to sleep off the effects of the liquor before 7 A. M. This movement met with the hearty support of the officials of some other companies. It ought to have the support of every man connected with the industry, mine workers as well as officials.

Unfortunately, the movement has met with opposition. Naturally, some barkeepers oppose it. Then some mine workers who mistakenly think the movement is an insulting reflection on the sobriety of the workingman, and an insiduous attack on his personal liberty, also oppose it.

The opposition of the barkeepers to the movement is of no account. The opposition of any considerable number of mine workers is. This opposition, however, will fade away when those adhering to it really understand the movement and its benefit to them.

Mine workers, regardless of whether they are total abstainers or occasional drinkers, should join hands in supporting a movement to keep all bars in mining communities closed until after 7 o'clock in the morning. None but hard drinkers want a drink of liquor in the early morning hours, and if such hard drinkers are mine workers on their way to work they shouldn't have it. For such men one drink seldom suffices, and as the effects of the liquor may not show at once they are allowed to enter the mine. Once in the mine, they go to their working places and if, as is invariably the case, intoxication in any degree follows, they are practically alone and in position to do some fool act that may not only bring disaster to them, but to many others if not all of the men in the mine.

In some sections of the country the Judges in granting licenses restrict the hours during which liquor can be sold. In those sections there is no necessity for such a movement as has been initiated by the officials of the Lackawanna company. But where there are practically no restrictions, except those against keeping bars open on Sundays and election days, a similar movement cannot be started too soon, and if the movement has the support of both mine workers and mine officials it will be effective. In most cases the barkeepers will voluntarily comply with its requirements, and those who will not, will undoubtedly lose their licenses, for the Judges in every case will accede to the reasonable demands of the combined mine workers and mine officials.

As to the movement being a blow at the personal liberty of the mine workers—that is the argument of fools. By the same token the law that prohibits the use of open lights in a gaseous mine is a blow at personal liberty. An open light is a better illuminator than a safety lamp, and not so cumbersome, and in many instances is no more menace to the safety of the mine workers than a drunken man is.

Industrial Relations Commission

When John Hays Hammond was being interrogated by the Industrial Relations Commission Survey, he took direct issue with all the millionaires who preceded him in discussing the causes for strikes. He declared that "it would be decidedly improper for directors to permit delegations of employes to appeal to them over the heads of the active managers when strikes threaten."

"No high-grade manager would submit to the dictation of the directors who interfered with his labor policies." "The manager is conversant with labor and he should be backed by the directors whose business really should be only to handle the finances of the corporation." Later in the course of the survey, J. P. Morgan stated "that directors of corporations know nothing of the actual work or the labor conditions, that part of the corporation's business being in charge of officers who had the oversight of the production and of the men."

While Mr. Hammond's logic is sound, probably all of us can recall some impolitic mine manager who has followed the suggestion advocated and has found himself without position and had tacked to his recommendation "bull headed."

It is true that occasionally a mine manager has an exaggerated opinion of his position and fails to comprehend that he is but a larger cog in the same machine as the miner. However, as a rule, mine managers are better able to deal with working conditions than directors; are as liberal to the men under them as market conditions will permit or the labor unions allow; also are as human and charitable as those clergymen who, with impracticable business ideas, endeavor to get in the lime light by expressing radical views that mislead and cause trouble.

As an illustration of what would follow if directors were to deal with the men instead of the managers the present Ohio mine difficulties are cited:

The miners in Ohio appealed to the legislators to prevent their union officials making contracts with the operators, which they claimed were detrimental to their interests. Governor Cox and the Ohio Legislature took notice of this petition and a commission was appointed that formulated five laws, three of which were passed by the legislature.

One law provided that all coal mined should be paid for at a rate which prohibited mining, as it was more than the union miners across the river in Pennsylvania and West Virginia were paid. The eastern Ohio mines have been idle since the law went into effect last April, and much suffering has prevailed, because legislators, not knowing conditions so well as the union officials, mixed in the labor managers' affairs.

We have known instances of similar chaotic conditions which happened when directors removed the manager because he knew the men and the work while they did not.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Forced Draft

Editor The Colliery Engineer:

SIR:—I expect in the near future to install a boiler plant of considerable size and I want to use slack of somewhat inferior quality for fuel. This, of necessity, will require the adoption of some appliance to produce forced draft. I have had some little experience with steam jet blowers, but have had none with fan blowers run by small steam turbines. Will some of your readers who have had practical experience with each type of blowers, kindly give me the benefit of their opinions as to the relative merits of each? I can get from the manufacturers their claims of superiority, but that is not what I want. I want the results of actual use at mines where small sized inferior fuel is used, and will appreciate the information given me through your columns by brother mine managers or other mine officials. I prefer, for obvious reasons, that my name and address be not made public at this time.

MINE MANAGER

Wooden or Steel Cages

Editor The Colliery Engineer:

SIR:—The question of steel *versus* wooden cages I notice has gotten into the legislature. From a legislator's standpoint, there seems to be no reason why steel cages should not be adopted at all mines instead of wooden cages, but there are several important matters which enter into the subject.

Steel cages are heavy, cost more, and must be more carefully examined than wooden cages; further, they must be kept painted in every joint to prevent corrosion. The latter is a difficult matter to observe, particularly where steel cages are used in wet shafts, for it requires that the joints be washed then dried and carefully examined with a glass, otherwise signs of corrosion will go undetected. Another feature which the legislators probably overlook is that a duplicate cage must be kept on the surface to replace the one in use should an accident happen, and that this cage although it may be housed and coated with paint may corrode in the joints where the defect may not be discovered. It will not do to make steel cages light because 10 men on a cage have considerable weight, and steel is apt to bend or buckle much more readily than wood, which for the same strength is stiffer.

Stiffness is required in cage members because of the spring which occurs due to the elasticity of the rope when the cage comes to the landing and stops. Light steel members, while having sufficient strength to withstand rupture under ordinary conditions, will be unable to withstand bending and eventually will break under such conditions; therefore, if a bill is to be passed, the size of the steel members should be specified, otherwise it may cause greater loss of life than would occur with wooden cages.

Wooden cages, if properly constructed and examined from time to time, not while hanging in the shaft but when at the surface, will prove as serviceable as, if not more so, than steel. An eye examination is not sufficient; the cage members must be taken apart, examined for defects, and if all right replaced; and in the writer's opinion this method of examination should be required also in the case of steel cages, if they are compulsory.

C. O.

Lansford, Pa.

"Dead Hole"

Editor The Colliery Engineer:

SIR:—The following is an extract from the Illinois coal mining law of 1913:

"A 'dead hole' is a hole where the width of the shot at the point measured at right angles to the line of the hole is so great that the heel is not of sufficient strength to at least balance the resistance at that point. The heel means that part of the shot which lies outside of the powder.

"In solid shooting, the width of the shot at the point, in seams of coal 6 feet or less in height, shall not be greater than the height of the coal, and in seams of coal more than 6 feet in thickness, the width of the shot at the point shall, in no case, be more than 6 feet.

"In undercut coal, no hole shall be drilled 'on the solid' for any part of its length."

As a mining engineer of considerable practical experience in coal mining, I am unable, notwithstanding a collegiate education, to translate the quotation into such plain English as will specifically tell what is meant by a "dead hole" in Illinois. Won't some Illinois engineer or mine official kindly explain the meaning, using diagrams, if necessary, and thereby give me the information which I am apparently too dense to find by personal analysis of the language used in the law?

E. M.

Wilkes-Barre, Pa.

Experiments made at the Bureau of Mines have shown that an explosion could be produced when there was only .032 ounce of coal dust suspended in each cubic foot of air or 1 pound in 500 cubic feet of air. In one instance M. J. Taffanel, at Lievin, France, exploded so low a weight as .023 ounce coal dust per cubic foot space.

ANSWERS TO EXAMINATION QUESTIONS

Questions Selected From Those Asked at Examinations for Mine Foreman and Fire Boss in Various States in 1914

QUES. 1.—Find the cubical contents of a bar of iron 10 feet long and 1½ inches in diameter.

ANS.—The area of metal in the cross-section of the bar is $.7854 \times d^2 = .7854 \times 1.5^2 = 1.767$ square inches. The cubical contents of the bar is equal to the area of its cross-section, in square inches, multiplied by its length, in inches, and is, $1.767 \times (12 \times 10) = 212$ cubic inches.

QUES. 2.—What is a regulator, and when can it be used to advantage?

ANS.—A regulator is a device for increasing or decreasing the quantity of air received by a particular part of the mine, and usually consists of a brattice or stopping in which there is a sliding door or shutter, the opening or closing of which decreases or increases the resistance to the passage of the air and, hence, increases or decreases the quantity in circulation.

If two headings have the same length and same area, each will offer the same resistance to the passage of the air, and if ventilated by separate splits, each should have the same quantity of air in circulation. But if the resistance in the airways becomes unequal, the one offering the least resistance will have more air circulating through it than the other. By placing a regulator in the return of the heading receiving the most air, the resistance will be increased until it is the same in both airways, when each will receive equal amounts of air. A regulator would be used for the foregoing reason if it was necessary to give a long heading as much air as a short one. Another condition requiring the use of a regulator would arise should an outburst of gas, or any other reason, demand more air in one heading than another. In such a case, a regulator would be placed in the return of the heading requiring the least air, and its shutter adjusted until the resistance in that return was such that the other heading received the proper amount of air to dilute the gas.

QUES. 3.—Find cubical contents of a bar of iron 10 feet long, and having its ends 1½ inches square.

ANS.—The area of metal in the cross-section of the bar is $1.5 \times 1.5 = 2.25$ square inches. The cubical contents of the bar is equal to the area of its cross-section, in square inches, multiplied by its length, in inches, and is $2.25 \times (12 \times 10) = 270$ cubic inches.

QUES. 4.—Discuss briefly the relative merits of oil lamps, carbide lamps, and electric lamps for general mine use.

ANS.—Oil lamps are cheap in first cost, will burn almost any kind of oil or grease to be found around a mine, and do not get out of order. They consume a very large amount of oxygen in proportion to the light they give and throw off a correspondingly large amount of CO_2, and unburned carbon as smoke, etc., all of which are objectionable in places where the circulation of air is sluggish. Their open flame is dangerous in gassy or dusty mines, and numerous fires have been caused by their flame coming in contact with canvas curtains, hay, oil-soaked wood, etc., or by carelessly throwing a used, but still burning, wick upon a mass of combustible material. The lamps are dirty and go out in an atmosphere slightly deficient in oxygen, but one in which men can safely work for some time if necessity requires it.

Carbide lamps are comparatively low in first cost, burn only acetylene gas generated from calcium carbide, and while occasionally they become stopped up, are soon put in order. They consume much less oxygen than oil lamps, do not throw off smoke, and are, hence, much better adapted than oil lamps for use where the air is sluggish, and they are cleaner and give a much better light. They are not safe in gaseous atmospheres, but are not liable to set hay, etc., on fire, as there is no dropping of burning oil from their spouts. Trouble sometimes arises by carelessly throwing partly spent carbide upon wet material or upon water, or by emptying the contents of the lamp, while it is wet and still generating acetylene, upon inflammable material; in which cases a fire may result. Carbide lamps may be used in an atmosphere containing much less oxygen than an oil lamp, which is sometimes of advantage in an emergency and at other times a source of danger.

Portable electric lamps are high in first cost, require a generator to furnish the electric current to charge them, and do not get out of order unless deliberately mishandled. The lamp does not consume oxygen and so does not give off gas or smoke of any kind. Lamps of this type which have passed the tests of the Bureau of Mines and are, thence, known as permissible, are safe in any gaseous or dusty atmosphere;

and it is impossible for them to set fire to hay, timber, or other inflammable material. The current costs less than oil, the lamps are clean, give an excellent light, and are highly esteemed for general use.

Ques. 5.—There is 11,798 cubic feet of air under a pressure of 130 pounds per square inch. If the pressure is reduced to 75 pounds per square inch, what will be the volume of the air?

Ans.—If the temperature of the air is not changed during expansion, the volumes are inversely proportional to the pressures; that is, at a pressure of 75 pounds per square inch, a given volume of air will occupy more space than at 130 pounds in the ratio of 75 to 130. The volume at the lesser pressure may be found from the proportion, $75:130 = 11{,}798:x$, from which $x = 20{,}450$ cubic feet, very nearly.

Ques. 6.—How does a change in the atmospheric pressure affect a gaseous mine?

Ans.—Whether an increase or decrease in the pressure of the atmosphere has any practical affect upon the amount of gas in the air-currents of a mine, is a disputed question. In this connection it may be noted that the so-called *barometer warnings* never had the authority of the British Government and have been discontinued for some time past as being of no practical value and as tending to cause accidents through the uneasiness of the men. Also, the United States Department of Agriculture (Weather Bureau) at the instance of the Bureau of Mines, after issuing one or two similar warnings, dropped the matter, and without giving a reason therefor.

At sea level, a fall of ½ inch in the barometer (which is unusually large) means a reduction in atmospheric pressure of about .245 pound per square inch. Any reduction in atmospheric pressure naturally reduces the pressure against which gas issues into the mine air from the coal face and from blowers, and by reducing the pressure in the old workings causes the air in them to expand into the live workings bringing with it any contained gas. But the gas given off by the coal is under a pressure of from 500 to 3,000 pounds per square inch and a reduction of .245 pound, or $\frac{1}{2000}$ to $\frac{1}{12000}$ of the total, is too insignificant to have any measureable effect upon the amount of gas coming into the workings in this way.

Whether a fall in the barometer will release enough gas from old workings to render dangerous an otherwise safe air-current, is the matter in dispute. Unquestionably, a lowering of the pressure will release from old workings a volume of air and gas proportional to the fall in pressure and to the extent of the workings. This air and gas mixture will be given off slowly and will be diluted by the pure air of the intake below the danger point. Further, it is found that when the percentage of methane in the air of old workings is high the amount of CO_2 also present is generally enough to make the air mixture inexplosive. Everything considered, it may be said that the effect upon the mine air by reason of gas issuing from old workings during seasons of low barometer is exaggerated, and in the case of well ventilated and well cared for mines is insignificant.

Ques. 7.—If 25,000 cubic feet per minute of air and gas at the most explosive point is passing through a mine, what is the quantity of gas given off, and what quantity of air should be added to the mixture to render it non-explosive?

Ans.—A mixture of air and gas containing 9.46 per cent. of methane is at the most explosive point. The air in the problem contains, then, $25{,}000 \times .0946 = 2{,}365$ cubic feet of gas. The word non-explosive is indefinite, because the explosibility of a gaseous mixture will depend upon the means taken to ignite it, the temperature and pressure, the presence or absence of explosive coal dust, etc. Assuming normal temperature and pressure and the absence of coal dust, methane may be considered inexplosive when, say, not more than 5 per cent. is present in the air. Then a mixture containing 2,365 cubic feet of methane should have a volume of $2{,}365 \div .05 = 47{,}300$ cubic feet if it is to contain but 5 per cent. of the gas. But the original volume of the mixture is 25,000 cubic feet, hence there must be added to it $47{,}300 - 25{,}000 = 22{,}300$ cubic feet of air per minute to make it non-explosive. Any such percentage of gas is extremely dangerous and not to be tolerated.

Ques. 8.—Which would require the use of larger pillars, and why: a mine with a hard bottom and soft top, or one with a soft bottom and hard top?

Ans.—The size of pillar will depend upon the kind and amount of pressure it is called upon to support. In a deep mine where the pillars must support the weight of the overlying rocks from the coal seam to the surface, a mine with a soft bottom requires the larger pillars so that the weight is distributed over a larger area and the pillars will not be forced down into the soft underclay, thereby resulting in the closing of the workings. In shallow workings, where the surface pressure is not great, the mine with the hard bottom and soft top may require the larger pillars, if the fall of roof is to be kept within reasonable limits. To avoid the expense of timbering where the roof falls to a considerable height, it is usual to drive very narrow rooms with large pillars, which are subsequently split up their length by a narrow room, and the two resulting pillars drawn back, allowing the roof to fall. The question of relative size of room and pillar depends upon several important points not raised in the question, and can only be answered generally unless these are considered.

Ques. 9.—The water gauge in a a mine reads 2.5 inches; we have a 60-horsepower engine running the fan. What quantity of air are we getting?

Ans.—The quantity of air circulated by an engine of a given horsepower will depend upon the mechanical efficiency of the plant, that is, of the fan and engine combined. If this is assumed to be, say, 70 per

cent., then $60 \times .70 = 42$ horsepower will be effective in moving the air. The quantity of air in circulation is $q = \frac{u}{p} = \frac{42 \times 33{,}000}{2.5 \times 5.2} = 106{,}615$ cubic feet per minute, very nearly. In the formula, u = the foot-pounds of work per minute, which is equal to horsepower multiplied by the units of work in 1 horsepower; and p = the pressure in pounds per square foot, which is equal to the reading of the water gauge, in inches, multiplied by the pressure equivalent to 1 inch of water gauge, or 5.2 pounds.

Ques. 10.—In a mine we are producing 40,000 cubic feet of air per minute with 20 horsepower; how many horsepower will it take to produce 50,000 cubic feet, the conditions remaining unchanged?

Ans.—The horsepower required to move the air is proportional to the cube of the quantity of air in circulation, hence $(40{,}000)^3 : (50{,}000)^3 = 20 : x$, or $4^3 : 5^3 = 20 : x$, or $64 : 125 = 20 : x$, from which x = the required horsepower = 39.1, very nearly, or, say, 40 horsepower.

Ques. 11.—(*a*) How many gallons of water are contained in a sump 8 feet wide, 10 feet deep, and 90 feet long?

(*b*) How long would it take a pump discharging 80 gallons per minute to empty the sump?

Ans.—(*a*) The number of cubic feet of water in the sump is found by multiplying together its three dimensions, and is $8 \times 10 \times 90 = 7{,}200$ cubic feet. Since 1 cubic foot contains 7.48 gallons, the quantity of water in the sump is equal to $7{,}200 \times 7.48 = 53{,}856$ gallons.

(*b*) At the rate of 80 gallons per minute it will take the pump $53{,}856 \div 80 = 673.2$ minutes = 11.22 hours = 11 hours 13 minutes, say 11¼ hours to empty the sump.

Ques. 12.—Who should be intrusted with a safety lamp, and when and where should you use safety lamps in coal mines?

Ans.—Safety lamps should only be given to those men who have satisfied the mine foreman that they know how to handle them properly. Such tests are best made in the mine under actual working conditions rather than in the lamp house on the surface. The miner must know not only the indications of gas, but also how to handle the lamp and himself should gas be found. He should know how to protect the lamp from accidental injury while he is at work, how to pick it up and set it down, how to carry it in strong air-currents, and what to do with it in the various emergencies that may arise. In particular, he must thoroughly understand the danger of tampering with the lamp or its lock, or attempting to open it to light a pipe or for any other reason.

Safety lamps should be used in all parts of the mine where gas is regularly given off or where it may be carried in sufficient quantity to be detected in a lamp, in exploring old workings, and in pillar and other workings where a sudden inflow of gas may be expected.

Ques. 13.—(*a*) How many cubic feet are there in a room 240 feet long, 24 feet wide, when the coal is 7 feet thick?

(*b*) How long would it take to empty the room of air and gas if air was forced in at the intake through a sectional area, 4 ft. × 4 ft., at a velocity of 2 feet per second?

Ans.—(*a*) The number of cubic feet in the room is found by multiplying together its three dimensions, and is $240 \times 24 \times 7 = 40{,}320$.

(*b*) The volume of air entering through the intake is $(4 \times 4) \times 2 = 32$ cubic feet per second. At the rate of 32 cubic feet per second it will require $40{,}320 \div 32 = 1{,}260$ seconds = 21 minutes to empty the room of air and gas. This is the theoretical time; in practice it would probably take decidedly longer to remove the last trace of gas, because the entering air would mix with the gas in the room and dilute it, and not sweep it before it, as would a piston in a cylinder.

Ques. 14.—If, while making an examination on a fall, your lamp becomes extinguished, how would you determine what gas or gases were present?

Ans.—The reason that gas is found in cavities in the roof over falls is not due to the rising of the gas toward the roof, but to gas given off by cracks in the rocks that form the hole from which the fall has dropped. For this reason the gas may be either methane or carbon dioxide, and probably the first, as it is more common. Either gas, if undiluted, will extinguish a flame at once and cannot be told apart. Usually, however, there will be a little air within the lamp or the change from the air in the room to that in the cavity will not be instantaneous, and there will thence be enough oxygen for the lamp to flame for a very short interval of time before the pure gas extinguishes it. If the lamp shows a slight flame, the presence of methane is indicated; if the lamp goes out, while either CH_4 or CO_2 may be present, it is probably the former, as CO_2 is rather rare under usual working conditions.

Ques. 15.—An indicator attached to a winding drum is run by means of a gear-wheel meshing with a worm on the end of the shaft; the small gear-wheel that is connected to the pointer has 16 teeth and the circumference of the dial is 32 inches; how far will the pointer move for each revolution of the drum?

Ans.—The worm will revolve at the same rate as the drum, that is, they will make the same number of revolutions per minute. But since there are 16 teeth in the gear-wheel it will require 16 revolutions of the worm, or, what is the same thing, 16 revolutions of the drum, to make one revolution of the pointer. Since the pointer moves around the dial once, a distance of 32 inches for 16 revolutions of the drum, it will move $32 \div 16 = 2$ inches for a single revolution of the drum.

Ques. 16.—If the anemometer records a velocity of 500 feet per minute in an intake airway having a sectional area of 60 square feet at a time when the thermometer registers a temperature of 32° F., what will be the volume of air passing per

minute in the same airway when the thermometer has risen to 60° F.?

Ans.—At a velocity of 500 feet per minute there will be 500 × 60 = 30,000 cubic feet of air passing per minute at 32° F., and as long as the velocity is not changed there will be 30,000 cubic feet at 60 degrees or 100 degrees. The quantity of air depends only upon its velocity and the area of the airway; but the weight of 30,000 cubic feet of air is less at 60 degrees than at 32 degrees.

As the thermometer rises, a given volume of air will expand in proportion to its absolute temperature. So a volume of air which measures 30,000 cubic feet at 32 degrees will measure

$$30{,}000 \times \frac{460+60}{460+32} = 31{,}700 \text{ cubic feet, about,}$$

when the temperature rises to 60 degrees. To get this quantity of air through an airway 60 square feet in area will require a velocity of 31,700 ÷ 60 = 528 feet per minute, and not 500 feet as given in the question.

OBITUARY

WILLIAM FAIRLEY

William Fairley, Ph. D., F. G. S., who from March, 1893, till February, 1894, was assistant editor of The Colliery Engineer, died at Wigan, England, on January 4. Mr. Fairley was one of the most prominent mining engineers in Great Britain, and was particularly well known in the county of Durham. He was a fluent writer and was the author of numerous books on coal mining. His best known works were "The Colliery Manager's Calculator," "The Colliery Manager's Catechism," "Practical Observations on the South Wales Coal Field," "Notes on a Visit to Saxony," "Geologische Bemerkungen über Dean Forest und Umgegend," and "The Theory and Practice of Ventilating Coal Mines." His last book was "The Practice and Science of Mining Engineering," which was published in 1896. Mr. Fairley was a man of remarkable ability in imparting technical coal mining principles in language easily understood by men of limited elementary education.

DAVID G. JONES

The mining fraternity heard with regret of the death of David G. Jones, secretary-treasurer and general manager of the Pittsburg-Buffalo Coal Co., at Pittsburg, Pa., on January 16. Being of such a rugged and vigorous physique, his death came as a pronounced shock.

Mr. Jones was interested as a stockholder, officer, and director in a great many other companies, among which are the following: President of the Four States Coal and Coke Co., president of the Dexter Coal Co., president of the Johnetta Coal Co., president of the Rayland Coal Co., vice-president of the Big Coal Co. of West Virginia, secretary and treasurer of the Pittsburg-Buffalo Co. of Illinois, secretary of the Pittsburg & Buffalo Co. of New York, secretary and treasurer of the United States Sewer Pipe Co., director of the Pittsburg & Buffalo Co. of Ohio, director of the First National Bank of Finleyville, Pa., director of the First National Bank of Wilson, Pa., director of the Citizens Trust Co. of Canonsburg, Pa., treasurer of the Lake Erie & Ohio River Ship Canal Co.

O. S. BLAIR

O. S. Blair, general superintendent of the Washington Coal and Coke Co., died on February 1 at his home at Star Junction, Pa. He was in his 63d year and had been confined to his home for the past five months. He was employed by the Washington Coal and Coke Co. in 1892 and was continuously with the company until his death.

SAMUEL M. DALZELL

Samuel M. Dalzell, general manager of the Spring Valley Coal Co., died recently at his home in Chicago, in his 65th year. He was general manager of the Spring Valley properties for 26 years.

Mr. Dalzell was prominent for years in all the interstate wage conferences between the operators and the miners, and took part in the first joint wage conference. He was president of the Illinois Third Vein Coal Co., and the Ladd Mercantile Co. For many years he was prominent as a club man and in Masonic circles.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Heaton's Annual, the Commercial Handbook of Canada, 1915 edition, price $1, postage 12 cents, Heaton's Agency, Toronto. Year by year this Annual has been developed to meet the requirements of those who want a Canadian book of easy reference. Heaton's Annual is indispensable to financial or commercial firms having business relations with Canada. In the first 218 pages will be found information which the business man must have at his elbow, including directories of government officials, members of Parliament, insurance companies, banks, railways and steamships, postal, parcel post, and cable rates, registry offices, commercial regulations, cost of travel, customs tariff, etc.

Illinois Coal Mining Practice. This is the ninth Bulletin issued by the Illinois Coal Mining Investigations Cooperative Agreement. The average room-and-pillar mine in Illinois loses about 50 per cent. of the coal in the bed. Improper dimensions of workings and the fear of squeezing causing surface subsidence, prevent pillar drawing in most mines. In District 3, however, two mines working on the room-and-pillar system have an extraction of coal almost equal to that obtained by longwall mining. The method of pillar drawing at these mines is described in Bulletin 9, Coal Mining Practice in District 3, by S. O. Andros, published by the Illinois Coal Mining Investigations Cooperative agreement. District 3 includes

those coal mines that are in Brown, Calhoun, Cass, Fulton, Greene, Hancock, Henry, Jersey, Knox, McDonough, Mercer, Morgan, Rock Island, Schuyler, Scott, and Warren counties which work in Rock Island coal or Bed No. 1 and in Colchester coal or Bed No. 2.

The annual production of the district is only 512,178 tons, and with a few notable exceptions the mines are primitive in method and equipment. Several counties contain no shipping mines and their production is gained by mining outcrops on farms and is turned to local domestic use. At one mine for many years dogs have been used for underground haulage.

Copies of the bulletin may be obtained free by addressing Illinois Coal Mining Investigations, Urbana, Ill.

The "Mechanical World" Pocket Book and Diary has reached its 28th year of publication. New sections are given on Structural Iron and Steel Work; the Strength of Flat Plates; Limit Gauges; Cost of Power; Proportions of Tee-Slots; Morse Tapers, etc. The section on Toothed Gearing has been rewritten and extended considerably. The sections on Gas Engines, Oil Engines, and on Suction Gas Producers have all been revised considerably. Various tables have been extended and the whole book thoroughly revised. The contents include a large collection of Notes, Rules, Tables, and Data for Mechanical Engineers as well as sections on Steam and the Steam Engine, Steam Turbines, Steam Boilers, Gas Engines, Oil Engines, Suction Gas Producers, Structural Iron and Steel Work, Shafting, Toothed Gearing, Gear Cutting, Milling, Limit Gauges, Notes on Belting, Rope Gearing, Wire Ropes, Spiral Gearing, Screw Cutting, Chain Driving, Verniers and Micrometers, Ball Bearings, Roller Bearings, and Hydraulics. The price has risen to 50 cents, post paid. The Norman, Remington Co., 308 North Charles Street, Baltimore, Md., is the publisher's representative in this country.

Coal Catechism, by William Jasper Nichols, published by J. B. Lippincott Co., Philadelphia and London. This little book of 250 pages is neatly bound in leather and contains in question and answer form, much information about coal. The preface states that the book is intended for that great number of intelligent readers without technical training, who have not time to peruse the geological and statistical reports of the industry or to study the technical literature. The book explains the origin of coal, its history, production, mining, preparation, transportation, heat, gas, coke, by-products, etc. There is a good index. In general the information is well stated, but we notice in the description of the method of bituminous mining that the miner is described as using an iron tamping bar and iron "tamping needle," with coal dust to tamp the shot, and firing it with a squib. Unfortunately all of these methods are used at times, but they are very dangerous, and most of them are forbidden by the laws of different states and by the company rules.

Electric Mine Signaling Installations. This little book of about 200 pages including 139 illustrations and index, is by G. W. L. Paterson. It deals with electric signaling entirely and seems to cover the subject fully in 10 chapters. It is so written and illustrated that almost any one can learn to install an electric signaling apparatus, either for permanent or temporary use. It is published by D. Van Nostrand Co., New York, and can be purchased for $1.50 net. The growing importance of electric signaling apparatus, both audible and visual, in mines, makes it important that the elementary call bells and annunciators be understood by users. As electric signaling becomes more used it will become more complicated, and for that reason it should be understood to avoid delay due to the system getting out of order.

The Anode is a monthly bulletin published by the Bureau of Safety of the Anaconda Copper Mining Co. A. S. Richardson, editor and safety engineer. The Bureau of Safety is composed of C. W. Goodale, chairman, six managers of departments, and Vice-President Kelley. During the first year of the "Safety-First" movement accidents were cut down 50 per cent. from the previous year. It pays in other branches of industry besides coal mining.

Mine, Quarry, and Derrick is a new paper edited by J. C. Murray, B. A., B. S. C., and published at Calgary, Alberta, Can. It is neatly gotten up and as it covers a large field of endeavor it should have a large subscription list. Mr. Murray, it will be remembered, was once the editor of the *Canadian Mining Journal* with headquarters at Toronto, Can., and he is capable of furnishing a first-class journal.

The Tradesman, of Chattanooga, Tenn., has been combined with *Southern Machinery*, Atlanta, and is now termed *Iron Tradesman*. W. R. C. Smith Publishing Co., of Atlanta, Ga., are the publishers. F. C. Meyers, Grant Building, Atlanta, Ga., is managing editor.

The Prospect Explosion

An explosion of gas at the Prospect colliery of the Lehigh Valley Coal Co., on February 17, resulted in 13 men dead, 2 injured, and 1 missing. It took place in the No. 10 slope workings in the Red Ash seam. The Oakwood shaft just north of the city of Wilkes-Barre, Pa., is the main artery of the mine.

Owing to The Colliery Engineer going to press, it is impossible to give all the details. It is evident, however, that a heavy pocket of gas was ignited at the face of a chamber by the miners' lamps and then swept with great force out to the gangway, where it struck several men and boys who were eating their noonday lunch.

A slight fire followed the explosion, but this was extinguished. The man who is missing, is at this writing, supposed to be behind a fall of rock.

NEW MINING MACHINERY

Mounted Jackhamers

Jackhamer drills have been extensively adopted in coal mines for brushing top rock, taking up bottom rock, stripping cap rock, breaking down coal, driving gangways, rock tunnels, and general development work. The success of the Jackhamer has been due to its speedy operation, its ability to penetrate coal or rock without changing steels; to its easy operation; and comparatively light weight.

While the unmounted Jackhamer is suitable for most operations that will arise in coal mining, nevertheless, where there is continuous drilling with such a drill the effort of holding it is apt to tire the workman.

Realizing the need for a mounting that would not be cumbersome, the Ingersoll-Rand Co. developed the mounting shown in the accompanying illustration, which is known as the "JM-6" type.

It is but an instant's work to clamp the drill to this mounting, so that a single drill may be used conveniently for drilling flat holes or down holes without loss of time in making changes. When mounted, the Jackhamer retains its rapid drilling speed, its self-rotating feature, and the efficient means for keeping the bore hole clean. A water-feed device is used with the drill whenever troublesome dust arises. The clamp which grips the handle of the drill is provided with a cushion spring to take up the shock when a steel is being pulled out of a hole.

Fig. 1. The Mounted Jackhamer

The "JM-6" mounting is used either on a column arm or shaft bar, and the cone upon which the shell rests fits any 5-inch Sergeant saddle or clamp.

The total travel of the drill on its mounting is over 43 inches. The total weight of the mounting is 63 pounds.

Improved Coal Mining Machinery

While some new developments have characterized the progress in the electrical industry made by the General Electric Co. during 1914, the general advance consisted of improvements in apparatus that had attained relatively high efficiencies, both electrically and mechanically.

The essential features of the achievements embrace economical concentration of large energy values in single machines, and a broadening of the field of application based on experiment and exhaustive operating data.

Steam Turbogenerators.—Early in the year, the first large horizontal steam turbine generator set was installed. A still larger set, having an output of 30,000 kilowatts, 6,600 volts, 25 cycles at 1,500 revolutions per minute, and operating normally under 185 pounds steam pressure, was placed in service in New York in November, 1914, having been constructed and installed in less than a year. The effective concentration of energy value achieved in the construction of this machine is clearly indicated by the relatively small amount of space required for its installation. The overall dimensions are: length, 57 feet 4 inches; width, 19 feet 8 inches; and height, 14 feet 3 inches.

All of these large machines consist of a single generator direct connected to and mounted on the same bedplate with the turbine. They constitute the largest single generating units constructed, and those placed in service have established gratifying records in reliability, steam economy, and efficiency.

The simplicity and compact arrangement of these large turbogenerators made it possible to install a 12,500-kilowatt set within 14 days after its arrival at Toledo.

In striking contrast to the large machines is the diminutive turbo-generator developed during the year for supplying current for incandescent headlights. This set has a normal rating of 100 watts, 6 volts. at 3,600 revolutions per minute, and a maximum continuous capacity of 140 watts.

A steam pressure of about 90 pounds is maintained constantly by means of an automatic regulating inlet valve. The single-stage impulse turbine is coupled to a direct-current, compound-wound generator, and by means of a differential brake magnet coil, any fluctuations in the load are compensated, so that constant voltage is maintained from no load to full load.

Its overall dimensions are: length, 23½ inches; width, 15 inches; height, 14¾ inches; and its weight, 130 pounds.

Gas-Engine Driven Generators. Due to improvements in design and regulation, the past year has witnessed considerable advance in the use of 60-cycle, gas-engine-driven generators; and at the present time there are nearing completion three units of 1,390 kv-a. capacity, 2,300 volts, 60 cycles, arranged for operation at 116 revolutions per minute. They will be utilized by the Monongahela Traction Co., of Fairmont, W. Va., and are the largest 60-cycle generators designed for gas-engine drive. Other and larger units had, however, been constructed prior to 1914 for 25-cycle operation, the rating for these machines, which were built for the Bethlehem Steel Co., being 3,125 kv-a.

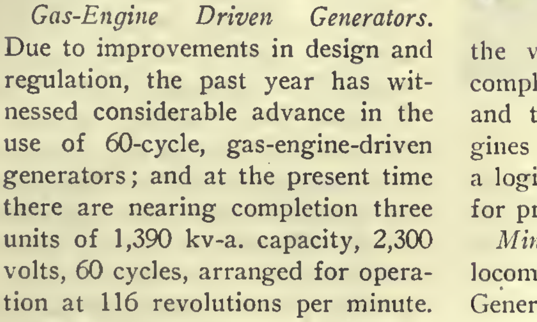


Fig. 2. Storage Battery Locomotive

An equitable basis of guarantee for the parallel operation of both gas-engine and steam-engine driven generators has been developed by the General Electric Co. which, if generally accepted, should prove of considerable value to the builders of engines and generators, and to the operator.

This guarantee is based largely on the determination of the natural period of the generator in relation to the various characteristics of the complete unit, including flywheel and the operating features of engines and governors, and presents in a logical manner the data necessary for predetermination of results.

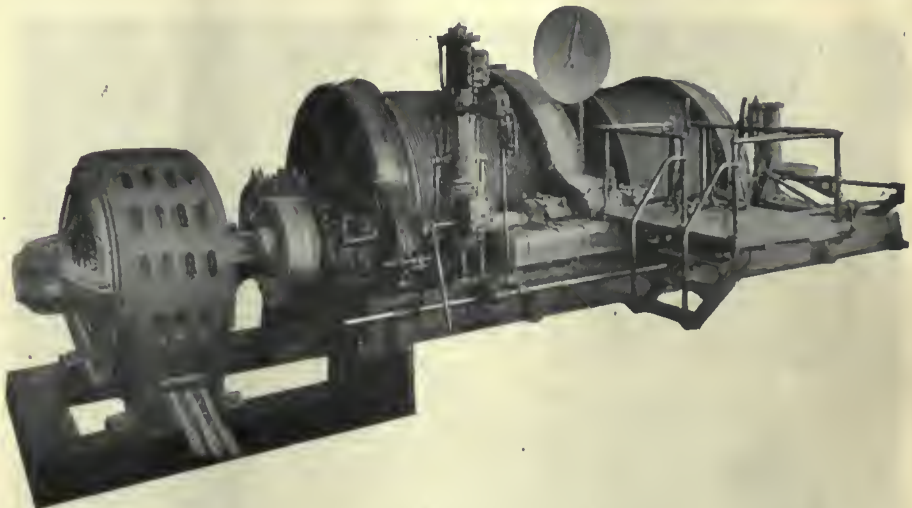


Fig. 3. Electric Mine Hoist, Lansford, Pa.

Mine Locomotives.—All of the mine locomotives manufactured by the General Electric Co. in 1914, were provided with commutating pole motors and ball bearings as standard equipment, and the operating records of those placed in service during the year show that these improvements have reduced the number of interruptions to service and have resulted in decreased maintenance costs.

The increasing output of many mines has rendered it necessary to equip with locomotives of relatively large capacity, capable of handling heavy trips over steep grades and for long hauls. For this class of service there has been built a number of three-motor, 15- and 20-ton locomotives. The 20-ton unit combines some unusual features in design and construction. The body is made of rolled steel, each side frame being cut from a solid rolled steel slab, while steel slabs in conjunction with steel channels are used for the end frames. The three driving motors are each rated at 85 horsepower and are of the split-frame type. These particular locomotives were built for a 42-inch gauge, but the same construction and capacity can be utilized for a minimum of 36-inch gauge.

Up-to-date practice in haulage locomotives may be represented by reference to the constructive features of a typical 16-ton, single-truck, three-motor unit. In this, the latest type of industrial locomotive, the truck frame is built of steel throughout, both the sides and ends being cut from single pieces of solid slab. The platform is built of steel channels and plates, and the cab of steel sheets. It is a standard-gauge machine; and, in so far as possible, all details have been developed along the lines of standard railway practice, the wheels, axles, journal boxes, brake beams, brake shoes, and couplings being all in accordance with M. C. B. requirements. It is driven by two 60-horsepower, 500-volt motors, and equipped with straight air brakes.

There has been a definite increased demand for the storage-battery locomotive for gathering work, as it has been demonstrated that in this service each locomotive will effectively displace at least two or three mules. Heavy machines are not as a rule required, and those so far provided

have been rated at from 3 to 7 tons. Most of these are of the straight storage-battery type; but a limited number have, in addition, been equipped so that they can operate from a trolley wire when in the main headings of a mine. The advantages of this arrangement are obvious in that by means of a small self-contained motor-generator set, the battery may be automatically charged while the locomotive is running on the trolley. When the locomotive is working in the rooms gathering the cars, a varying percentage of the battery charge will be consumed; but as soon as the locomotive is again operated on the trolley, these losses are compensated for.

With this dual system of operation, the battery need never be entirely discharged; and if space limitations are severe, it permits the use of a smaller battery than would otherwise be necessary. A representative machine of this kind has been in operation in a West Virginia mine for a period of about 4 months. It runs on a 42-inch gauge track and its overall height does not exceed 30 inches.

Mine Hoists.—The largest induction-motor, shaft-hoist equipment in America was placed in operation in November, 1914, at Lansford, Pa., for the Lehigh Coal and Navigation Co. The driving motor is rated at 750 horsepower, 300 revolutions per minute, three-phase, 25-cycle, and drives through a single reduction gear.

Positive control of the hoisting speed is secured by means of an improved liquid rheostat and high tension air-break contactors, the motor circuit being 2,300 volts. This hoist serves a 600-foot vertical shaft, hoisting 11,500 pounds per trip, at the rate of 90 trips per hour, with a maximum rope speed of approximately 1,600 feet per minute.

The liquid rheostat was developed primarily for mine hoist service and insures safe operation at quick reversal. It employs two sets of fixed electrodes at different elevations. One set is widely spaced, while the other set has large electrode areas and has small spacing in order to obtain a very low final slip. The two sets of electrodes are connected in parallel after the electrolyte has reached a certain level corresponding to a predetermined decrease in rotor voltage. All parts of the rheostat itself are stationary, thus insuring absolute reliability. The electrolyte level can be varied by means of the operation of a movable weir and a small motor-driven pump.

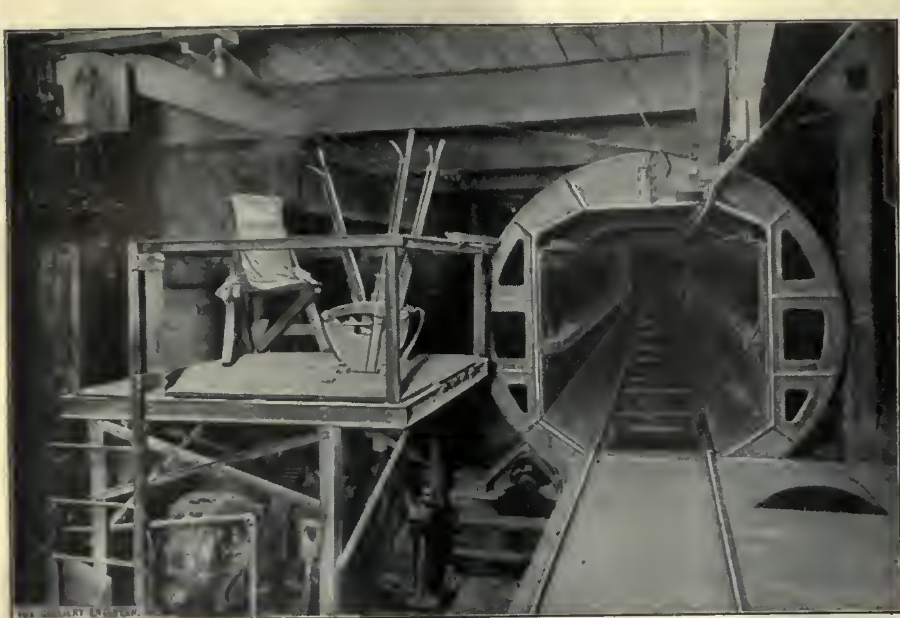


Fig. 4. Rotary Dump

A Successful Rotary Dump

In handling large outputs at coal mines, an important factor is a method of quickly dumping the loaded mine cars at the tipples or breakers, and the return of the empties to the mine. Rotary dumps for this purpose are not a new idea, but the one illustrated in Fig. 4 possesses features that are worth consideration.

While this dump is used at one of two similarly equipped shafts of the Ray Consolidated Copper Co., at Ray, Ariz., and is located underground to dump the ore into ore bins, the same arrangement can be applied to coal tipples. As will be noticed in the illustration, the dump is in the form of a large steel constructed tube long enough to hold one, two, three, or more mine cars. As used at the Ray mine, the entire trip, drawn by an electric locomotive is run through the dump as desired, leaving the last three cars "spotted" in the tipple. These cars of 5 tons (ore) capacity each, are disconnected from the trip, and one man operating the levers actuates an alternating-current motor of 12 to 15 horsepower which, through necessary gearing, turns the dump, and empties the mine cars into the chute. After dumping, the three empty cars are pushed out by the loaded train and three loaded cars left in place for dumping. At the Ray mines the cars are dumped at the rate of three revolutions, or nine cars per minute. Two of these triple dumps are used at each of the two hoisting shafts operated by the Ray company. The dumps are built entirely of steel and were the product of the Wellman-Seaver-Morgan Co., of Cleveland, Ohio.

If there is a disturbance sufficient to suspend a cloud of coal dust in the air and it comes in contact with a spark or flame, ignition may occur. The most common causes which give rise to these results are blasting shots, and the accumulation of an explosive mixture of firedamp and air. Mixtures of firedamp and air

are capable of transmitting flame and developing explosions only within narrow limits. Firedamp requires to be present in from 6 to 16 per cent. of the volume of the atmosphere. Below 6 per cent. there is not sufficient firedamp to propagate an explosion, while above 16 per cent. there is too much.

Portable Mine Pump

The Hayton Pump Co., of Quincy, Ill., have placed on the market a portable mine pump outfit, which consists of a centrifugal pump belt-driven by a gasoline engine mounted on a truck. The engine is 6 horsepower, and with the single-stage pump has a duty of 70 gallons per minute raised to a height of 100 feet, or with a multi-stage pump double this quantity for the same diameter impeller. The gasoline tank is detachable in order that it may be carried outside the mine for refilling and thus avoid any danger from fire.

As these pumps can only be used on the return air-current unless the mine is idle, the power may be changed to electricity if it is so desired. There are numerous times where pumps of this description will be found useful in coal mining. For instance in swampy places in flat-bedded mines; as auxiliary pumps in wet weather, or where the ground has recently caved and allowed water to enter the mine through surface cracks. Every mine manager will recall some period in his career where as a temporary expedient this arrangement

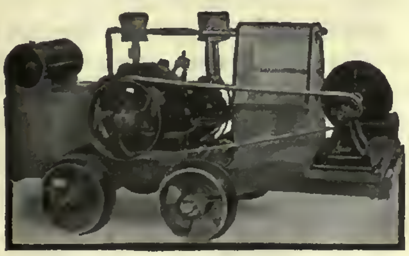


Fig. 5. Portable Pump

would have been very serviceable to him.

This pump is also recommended as a booster pump to increase the pressure of an existing pump, the elevation of which is not more than approximately 20 feet lower than the pump.

The Hayton Pump Co. make pumps for all kinds of service and guarantee each pump to satisfactorily perform the duties for which it is sold.

"Irenew" Valves

The William Powell Co., of Cincinnati, Ohio, are manufacturing a new valve which will interest mining men. Instead of throwing away a valve because the stem has stripped, it is only necessary to throw away the stem and replace it with a new one. Again, instead of discarding a valve because the seat or valve has been cut by water or steam, it is possible to renew the parts and retain the valve body.

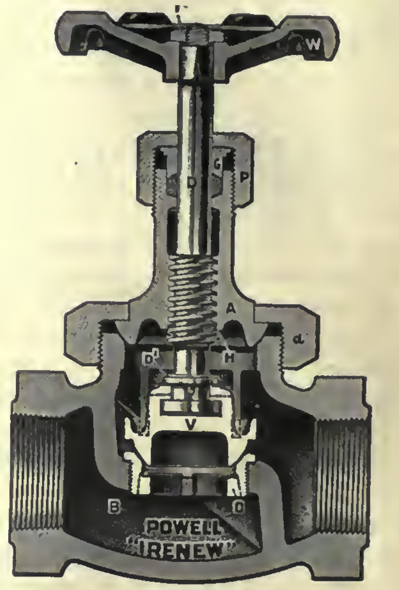
The seat ring *O* is cast of white "Powellium," a non-corrosive bronze metal applicable to most temperatures of superheated steam. Whenever a renewal is necessary the seat ring is unscrewed with a flat tool.

The renewable horseshoe valve *V* is arranged to slide on or off the head of the valve stem *D* into a socket whenever the valve needs regrinding or in case of renewal.

When it is desired to regrind the valve *V* and the valve seat *O*, the bonnet *A* is released by unscrewing the nut *a*. The valve trimming is then withdrawn, and the valve *V* locked by inserting a nail through the hole *L*. Fine sand or brick dust and soap water are applied to the two faces, after which the valve is rotated back and forth until a good bearing is had. The body of this valve is iron and all valves are tested to double their working pressure and unconditionally guaranteed. The "Irenew" seems to be a suitable name for this valve which is made in globe, angle, cross, and check-valve patterns. It is unnecessary to disconnect the valve body from the pipe when it is desired to regrind or to renew a leaky valve, because the parts can be removed and new ones replaced in the old body.

TRADE NOTICES

New Shops.—We have been favored with photographic views of the extensive new plant of the Toledo Pipe Threading Machine Co.,



Irenew Valve

showing the convenient and beautiful offices, the welfare department, lockers, wash trays, lunch tables, chairs, etc., the complete, excellently lighted and well-equipped machine shops, and the packing and shipping department. The constantly increasing demand for Toledo tools that necessiated the erection of the new plant is evidence that their merits are widely recognized by those who have to do with cutting or threading of pipe.

The Meadowlands Coal Co., whose large wooden tipple was burned down at Arden, Pa., during the month of December, have contracted with the Fairmont Mining Machinery Co. for a new steel tipple and complete equipment. The steel tipple is to be built and erected by the Penn Bridge Co., and the Fairmont company is to install the equipment complete, consisting of a double set of chutes and screens, loading boom, empty car haul, and ram for pushing the cars on and off the cages.

Telephone New York–San Francisco.—On January 25, 1915, tele-

phone conversation took place between New York and San Francisco, a distance of 3,400 miles, over very difficult country. There are four copper wires each 3,400 miles long and of No. 8 B. W. G.; these produce a total weight of 5,920,000 pounds or 2,960 tons. In the line itself there are 130,000 poles. The Western Electric Co., which supplied all of the line construction material and telephone apparatus used in conjunction with this transcontinental voice highway, has issued an attractive folder showing a map of the line, views taken during its construction, and reproductions of drawings and photographs depicting the opening of the first long-distance line between Salem and Boston, Mass., in 1877, the line between New York and Chicago in 1892, and that between New York and Denver in 1911.

Fire.—A part of that portion of the works of John A. Roebling's Sons Co., at Trenton, N. J., equipped with machinery for insulating wire for electrical purposes, was damaged by fire in January. The buildings burned were apart from the works used to manufacture wire rope and wire, and the major part of the electrical department remained in operation, admitting of the filling all orders for insulated wires. The company's capacity for the manufacture of wire rope and wire not insulated, was not affected in any way by the fire.

Chain Belt Co.—A 300-page catalog, No. 56, has been issued by the Chain Belt Co., Milwaukee, Wis. It contains a large number of photographs showing the uses to which chain belt has been put by this company. These range from elevators and conveyers for handling coal, ore, sand, ashes; traveling screens for water intakes of large power plants; concrete machinery, etc.; to machinery for handling packages, printed matter, bottled beer, and pies. The company claims that some product of its manufacture can be used in every industry. The catalog also lists all kinds of gears, sprockets, and conveyer parts.

Turbine Blowers.—The L. J. Wing Mfg. Co., 352 W. 13th Street, New York, has issued Bulletin 27 describing the Type E turbine blower for mechanical draft. Those interested in combustion of coal will find much value in it.

C. O. Bartlett & Snow Co., of Cleveland, Ohio, has designed a system whereby coal is unloaded, crushed, and elevated to a height of 125 feet and dumped into a storage bin. The company paraphrasing its name calls the arrangement the "Cobasco System" and claims it will care for 750 tons of coal per day at 1.5 cents per ton. Those who store coal, cokemakers, and others please note.

The Cottonwood Coal Co. has awarded to the Roberts and Schaefer Co. a contract for a complete fireproof coal tipple and coal washing plant to be erected at their new mine at Lehigh, Mont., the Cottonwood Coal Co. being the Coal Department of the Great Northern Railway. The tipple will have a capacity of 3,500 tons per day and will be built to accommodate both self-dumping cages and mine skips, and is to be equipped with modern coal screening and picking facilities, with electric motor drives throughout. The coal washery having a capacity of 2,000 tons daily will be built of reinforced concrete and steel, and equipped with facilities for coal drying, and will be electrically operated throughout.

Catalogs Received

Standard Wood Pipe Co., Williamsport, Pa. Circular illustrating methods of connecting wood pipe to Standard Screw Gate Valves, Flanged Gate Valves, Bell or Hub End Gate Valves and Wrought Iron Pipe and Pumps; Blue Book, Wood Water Pipe, 31 pages; Circular, Standard Steam Pipe Casing.

E. Keeler Co., Williamsport, Pa. Water-Tube Boilers, 45 pages; The Economical Burning of Coal as Accomplished by Ajax Shaking and Dumping Grates, 32 pages.

Hayton Pump Co., Quincy, Ill. Bulletin No. 9, Hayton Type H Centrifugal Pump, 4 pages; Bulletin No. 10, Hayton Type CS High Grade Centrifugal Pumps with Horizontally Split Casing, 8 pages.

American Blower Co., Detroit, Mich. Ventilating the Fletcher Savings and Trust Co. Building, 10 pages.

C. L. Berger & Sons Co., 37 Williams Street, Boston, Mass. Circular, Transits, and Levels; Circular, Six Hundred Transit Shots in Eight Hours.

Luitwieler Pumping Engine Co., Rochester, N. Y. The Luitwieler Non-Pulsating System, 40 pages.

Young & Sons, Philadelphia, Pa. Stadia Measurements, 6 pages; The Solar Transit, 20 pages.

C. O. Bartlett & Snow Co., Cleveland, Ohio. Bulletin No. 43, The Cobasco System, 8 pages.

Harris–Stevens Co., Pittsburg, Pa. Circular descriptive of Mine Cars.

Atlas Car and Mfg. Co., Cleveland, Ohio. Bulletin No. 1175, Storage Battery Locomotives, Cranes, and Cars, 32 pages.

L. J. Wing Mfg. Co., 352–362 West 13th Street, New York, N. Y. Air Handling and Power Plant Machinery, 20 pages.

Chain Belt Co., Milwaukee, Wis. General Catalog, No. 56, 303 pages.

Taylor Instrument Cos., Rochester, N. Y. Humidity, Its Effect on Our Health and Comfort, 24 pages.

Harrison Safety Boiler Works, 17th Street and Allegheny Avenue, Philadelphia, Pa. Cochrane Multiport Valves, 72 pages.

Terry Steam Turbine Co., Hartford, Conn. Bulletin 19, Centrifugal Pumps, 64 pages.

B. F. Sturtevant Co., Boston, Mass. General Catalog Number 195, Sturtevant Products, 113 pages.

J. C. Stine Co., Tyrone, Pa. An Electric Driven Pump, 4 pages; J. C. Stine Patented Disk Fans, 4 pages.

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Chignik Bay, Alaska, Coal Fields

A Region Much Affected by Faults and From Which Small Amounts of Coal Have Been Mined for Local Use

*By W. R. Crane**

CHIGNIK Bay is a broad indentation in the east coast of the Alaskan peninsula, Fig. 2. The coast line to the southward is very irregular and rough, even picturesquely so, due to the land sculpture of the stratified formations. Among the most striking and interesting features of this coast is the foreland known as Tuliumit Point, or Castle Cape, which is the most eastern point of the south shore of Chignik Bay.

The southwestern extension of the bay is Chignik lagoon into which the Chignik River empties. The lagoon is over 8 miles long, of irregular outline, is surrounded by rugged mountains on the south and east and by gently sloping lowlands on the west shore. Chignik River, about 3 miles long, drains Chignik Lake, a body of water some 6 miles long, which is also enclosed by rugged although not high mountains. The lagoon, river, and lake are at practically sea level, so low in fact that the tide affects the level of all of them, and owing to the holding back or damming-up action caused by the incoming or flood tides, a large quantity of water is stored in lake and lagoon. The outflow of this water on ebb tides causes a very swift current to flow through the lagoon making it both difficult and dangerous to navigate except with power boats.

The south and west shores of Chignik Bay are composed of the stratified rocks of the Upper Cretaceous period, locally known as the Chignik formation.† These are sandstones, shales, and conglomerates. Tertiary rocks occur directly back of the Cretaceous rocks, on the south shore of the bay and the south and southeast shores of the lagoon. The former rocks contain workable beds of coal while the latter carry beds of lignite.

Fig. 1. Igneous Intrusions on South Shore of Chignik Bay

Coal has been found on the west side of the lagoon and bay from the vicinity of Chignik River to the north side of the bay. The lignite beds occurring on the south side of the bay are thin and of little or no economic importance.

The Cretaceous sandstones, shales, and conglomerates of a portion of the south shores of Chignik lagoon and Chignik Bay are exposed in vertical section by the sea walls forming cliffs several hundred feet in height, Fig. 4. The conglomerate resembles pudding stone composed of pebbles and grit. The rocks are cut at numerous points by dikes of basalt, while on the south shore of Chignik Bay igneous intrusions occur, Fig. 1.

The long stretch of gently sloping lowlands on the northwest and west shores of Chignik Bay and lagoon conform in inclination with the dip of the strata, which is to the north and east. While having a fairly uniform dip for a distance of from one-half to several miles inland, yet further back they begin to show the effect of disturbances, and when the axis of the mountain is approached they are so folded and faulted that it is very difficult to correlate the different beds or to trace them con-

*Dean, School of Mines, Pennsylvania State College.

†U. S. G. S., Bulletin 467, pp. 41 and 51.

secutively, for even short distances. At a distance of from 1 to 3 miles from the beach, it is safe to say that if coal beds exist they have been so seriously disturbed by rock movements as to have been rendered worthless.

To the north is Hook Bay which is in reality a portion of Chignik Bay. This small indentation in the coast between two rough headlands, receives its name from a hook-shaped spit situated on the south shore of the bay near its entrance. The only coal bearing rocks in this locality occur on the south and west of the bay, and belong to the Chignik formation. The principal coal bearing formations in the vicinity of Hook Bay are an extension of similar formations occurring on the west shore of Chignik Bay, and the same conditions exist with the exception that, if possible, the distortion has been worse.

The coal beds are both thin and irregular and so far as developed are of small economic importance.

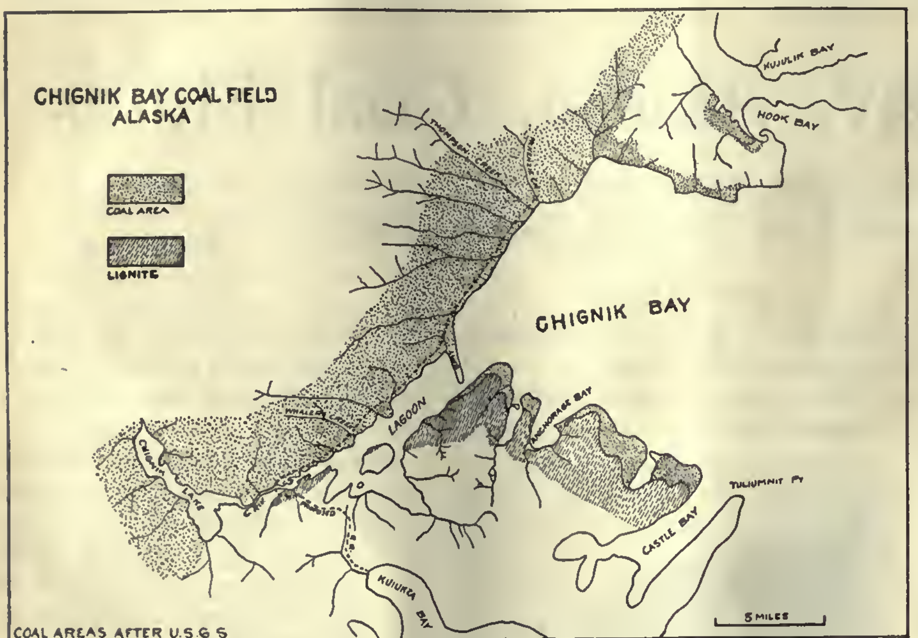
The coal bearing formations of the Chignik Bay region known to contain workable coal beds do not exceed 15 square miles although probably fully 50 square miles of coal bearing rock not known to contain workable coal beds occur in this region, which estimate includes both coal and lignite areas.

Coal was first mined near the mouth of Chignik River and was used in the cannery of the Alaska Packers Association on the south shore of Chignik lagoon. This coal is said to have pinched out. The coal formerly mined was transferred in barges to the cannery during the period of flood tide.

The Chignik Coal Mining Co. drove several drifts to the west of both the lagoon and bay on Whalers Creek. The principal occurrences of coal on this creek are on the first large branch extending to the northward, in which were run two drifts a short distance apart. Fig. 6.

The coal was carried by aerial ropeway from the mouth of the drifts down the stream and across the main creek to the east bank, where it was transferred into wagons and hauled to the lagoon. No work has been done here for several years and the drifts are badly caved in. Unfortunately these drifts were made at a point where a fault seriously disturbed the strata and completely displaced the coal bed.

A third opening was made into a coal bed, outcropping further down the creek, for a distance of 125 feet.



THE COLLIERY ENGINEER.

Fig. 2. Map of Chignik Bay Coal Field

This coal bed, about 6 feet thick, has numerous partings of shale and sandstone. The coal is firm and bright black, having the appearance of being of good quality. Several faults occur in the neighborhood of this opening which either partially or wholly displace the coal bed.

The frequency of the faults renders it difficult to determine with approximate accuracy the lay of the coal beds, but from observations taken, the dip is to the eastward with a mean inclination of 15 degrees, varying from 10 to 35 degrees.

Probably the most important occurrence of coal in this region is at Thompson Creek, where numerous outcrops are to be found on the north side of the valley, although owing to faults and minor folds it is very doubtful whether any particular bed is traceable for a considerable distance. However, there are two beds which maintain a relatively fixed distance apart for a mile or more. Several drifts have been driven in these beds, but not far enough to furnish definite information relative to their character and continuity.

Thompson Creek traverses a moderately wide valley remarkably uniform in surface and grade. It extends for a distance of 10 to 12 miles between mountains, which for the greater part of the way are very rugged and precipitous.

North of Thompson Creek, and scarcely over one-half mile distant at the shore, is McKenzie Creek, which roughly parallels the course of Thompson Creek although it has a more northerly course; these two creeks are separated by a spur of the mountains which within 2 miles of the bay has attained a height of fully 1,500 feet.

Coal beds outcrop on the north side of this range, but do not show as promising exposures as on the south side or in Thompson Valley. In one of the outcrops, some 500 feet above McKenzie Creek and about 2½ miles from the bay, a drift has been driven. At a distance of about 75 feet from the entrance to the drift

Fig. 3. Coal Outcrop on Thompson Creek

Fig. 4. Sea Wall, East Shore Chignik Lagoon

an incline has been driven diagonally down the dip of the coal bed. The main drift is 996 feet long, the incline being 90 feet in length.

The coal is about 9 feet thick near the entrance of the drift, but several hundred feet in it began to develop marked irregularities, particularly in the nature of partings, increasing and decreasing in thickness with surprising suddenness, and with very irregular and undulating strike and dip. At a distance of 900 feet from the surface the bed became so badly broken by partings and was so irregular and uncertain in position that further work was abandoned, and work on the incline was then begun, but with little better results. Owing to the incline being full of water, it was impossible to examine it.

Several fair-sized coal beds outcrop both above and below the site of the drift and along the course of McKenzie Creek. At all points the strata show signs of serious disturbance, and one 12-foot bed of apparently good looking coal was found to be largely composed of bony coal. About one-quarter of a mile below the drift a fault cuts the formations from the bed of McKenzie Creek to the summit of the mountains on the north side of the valley; and further, all beds below this faulted zone stand at high angles.

Owing to the extensive covering of moss and brush, on the slopes of the mountains in the McKenzie Valley it is difficult to examine the rock and coal exposures. Judging from such exposures as there are, the coal bearing formations have been more disturbed in the McKenzie than in the Thompson Valley. It is evident, however, that the ridge intervening between the two valleys, as well as the country lying both to the north and south of this area, have been so affected by folding and counterfolding that it is next to impossible to correlate the coal beds of the various parts of the district. Any attempt to connect beds from one exposure to another, to determine strike and dip, and to compare coal beds by comparing thickness, top and bottom formations and partings, leads

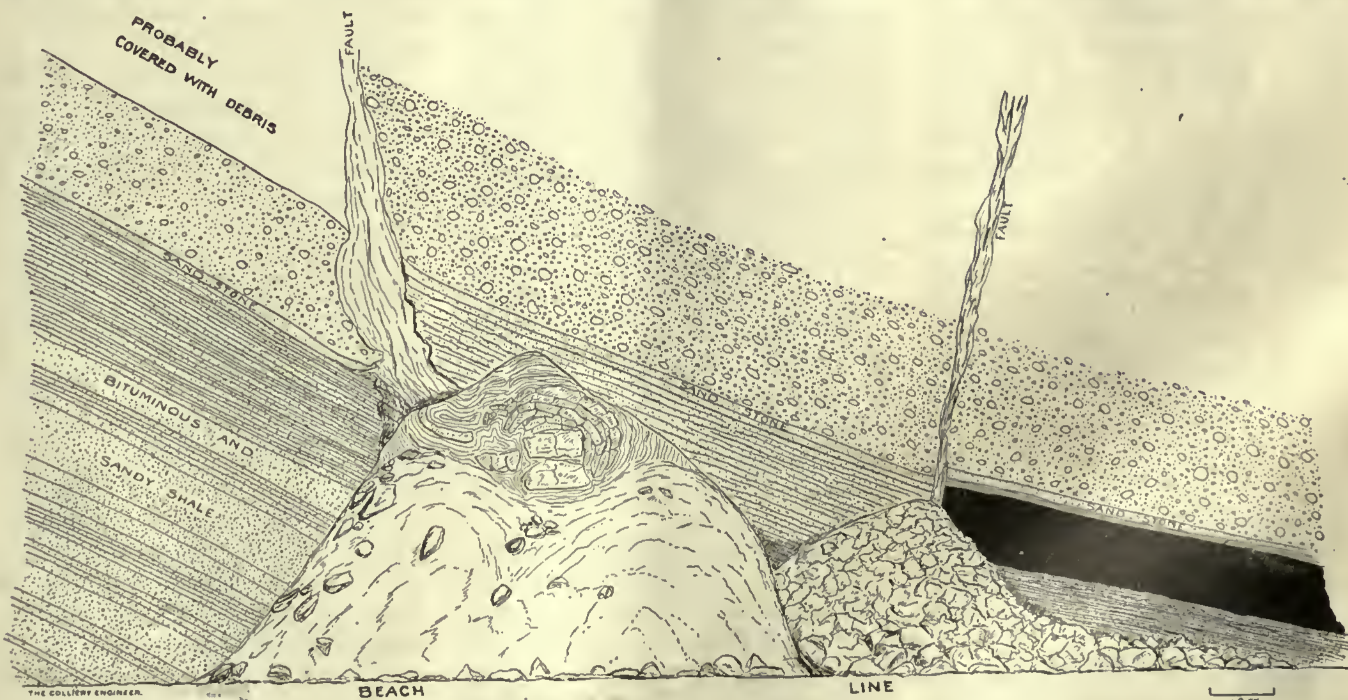


Fig. 5. Faults Cutting Coal Formation on East Shore of Chignik Bay Lagoon

to confusion, and any conclusions must be largely conjectural.

Passing to the north and eastward an area of recent volcanic rock enclosing Hook Bay intervenes between the coal bearing rocks and the coast. It is but natural to expect that the coal bearing formations occurring adjacent to such an area of igneous rock would be more or less seriously disturbed. This does not seem to be the case, however, except in certain localities.

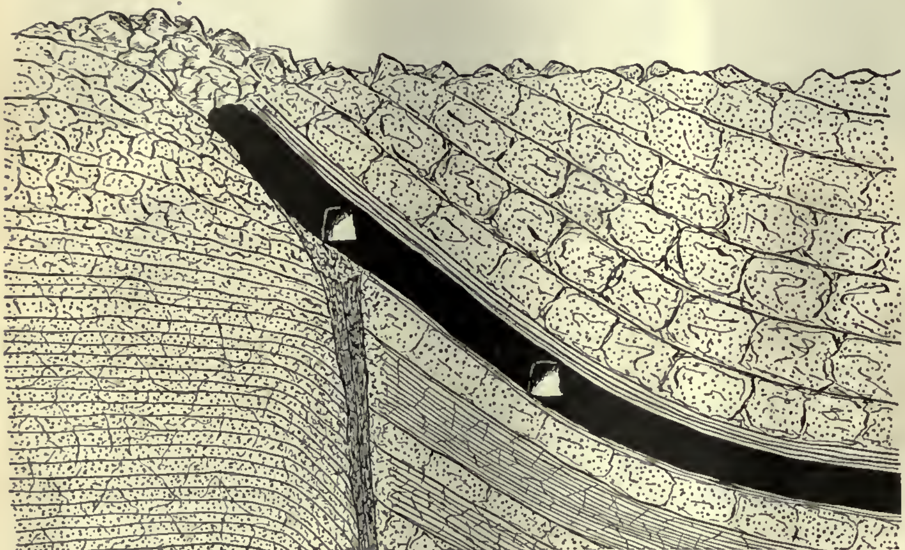


Fig. 6. Faults on Whalers Creek

It is reported that some 10 miles northeast of Thompson Valley a coal bed of workable size occurs, so broken by partings of shale, clay, and bony coal as to render it almost worthless. The exposure of the coal bed occurs for a distance of from three-quarters to 1 mile and with a fairly uniform strike and dip; but ultimately terminates in a badly disturbed and gnarled condition. Coal or lignite is reported to occur at Aniakchak Bay, probably a still further extension of the Chignik and Hook bays region.

The conditions of occurrence affecting the development and mining of coals in this region are: Varying strike and dip of beds, excessive folding and faulting, lack of uniformity and continuity of coal beds, and the presence of igneous dikes and sills.

The dip of the coal formations of the Chignik Bay region is to the north and east, and varies from 10 to 75 degrees. At various places in Thompson Valley the dip is to the northwest, but this may be reversed within a few rods, when a minor fold occurs; a complete reversal through 180 degrees was noted at one place. Many of the folds are so close as to apparently affect the dip only locally, although their effect on development work would be troublesome.

The close folding and the broken condition of the strata make the roof support difficult and permit large quantities of water to enter the mine workings. The same condition results from faulting, but the cutting off of coal beds and the isolation of certain areas will cause even more serious inconvenience to the operator. Further, owing to the rock movements the coal where not badly broken often has the cleavage planes very prominently developed, which causes the coal to break into relatively small pieces in mining and subsequent handling. In many localities, however, normal conditions exist, and the coal can be mined in fair-sized pieces thus making a good grade of mine run.

While numerous dikes and sills of igneous material occur, yet at no place was the coal bed observed to have been burned or coked; however, the outcrops being covered by broken rock, examination of the coal at the points of contact with the igneous intrusions was not always feasible. No dikes nor sills were observed in the coal bearing formations west of Chignik Bay and the lagoon, although they undoubtedly exist, particularly in the northern extension of the field to the westward of Hook Bay.

Conditions are unfavorable to mining in the Chignik Bay and Hook Bay region, and with the limited area of coal bearing rocks reduce the economic value of the region.

Owing to the shallowness of Chignik lagoon and the exposed position of the shores of the bay to storms from off the ocean, it is doubtful whether the docking of coal on the beach can be successfully accomplished. However, should future developments warrant the opening of coal mines, the product could readily be handled by rail. An excellent harbor to the south of Chignik Bay, known as Kuiukta Bay, is rendered accessible from Chignik Lagoon by a low pass connecting the two. A railroad could readily be built from this bay to and around the head of the lagoon, across Chignik River and thence along the west shore of the lagoon and bay, thus making connection with all operations in the region, with the possible exception of Hook Bay.

The following analysis* of the coals of the Chignik Bay region was made by the United States Geological Survey and is the average of four analyses:

Proximate Analysis of Chignik Bay Coals

	Per Cent.
Moisture (air drying)	4.55
Total moisture	6.98
Volatile and combustible matter	30.84
Fixed carbon	42.88
Sulphur	1.25
Ash	19.29
Calories	5,672
B. T. U.	10,210

The amount of sulphur is relatively small for Alaskan coals and does not occur, so far as the writer observed, as nodules or masses. The coal, while apparently firm, does not resist weathering well, as is shown by the ease with which it disintegrates on the steep slopes, rarely ever standing above the angle of the

*U. S. G. S., Bulletin 467, p. 105.

slope, except where protected by a harder stratum of rock above.

Owing to the scarcity of good wood for fuel the coal is often burned for heating and cooking, but the consumption for such purposes is very small. Some coal has been burned on the cannery tugs and a much larger amount in the canneries, although probably not much more than 9,129 tons have been mined in all.

The following estimate of coal mined in the Chignik Bay region has been furnished by Mr. H. S. Tibbey, manager of the Chignik Bay Coal Co.:

	Tons
The Alaska Packers mine, Chignik River	7,000
The Whalers Creek mine	550
The Thompson Valley mine	1,579
	9,129

Practically all of the coal mined has come from three localities, namely, Chignik River, Whalers Creek, and McKenzie Creek, or as commonly spoken of, Thompson Valley; the first and last localities mentioned being the largest producers.

The future of this field is not particularly promising, owing to the irregular occurrence of the coal beds and the physical condition of the coal. However, should Chignik Bay continue to be as important a fishing ground as in the past and the coals be mined and sold at a reasonable price, the local market for the coals would warrant considerable expenditures for development of the various properties. Carefulness must be the rule in the location of the openings, otherwise much money will be uselessly expended.

Taking Chances

As an illustration to show that "Safety First" requires more than a sign board, the case of two Kentucky miners is cited. These men went into a cloud of powder smoke, and sat down to wait until it should clear away. They died, as did three others in the same state from the same cause. A little education would have clinched "safety first" in their cases.

Surveying in Anthracite Mines

Methods Used by One of the Large Companies in the Upper Anthracite Field—Part 1, Details of Underground Work

By William Z. Price

THE following account of a large company's method was written for THE COLLIERY ENGINEER because it is simple, complete, and well worthy of adoption. The descriptive details will enable any engineer to adopt the system in its entirety. The second and concluding part of this article will appear in the May issue. Cuts of the transit notes and side notes will be reprinted to show their relation to the completed map.—[EDITOR.]

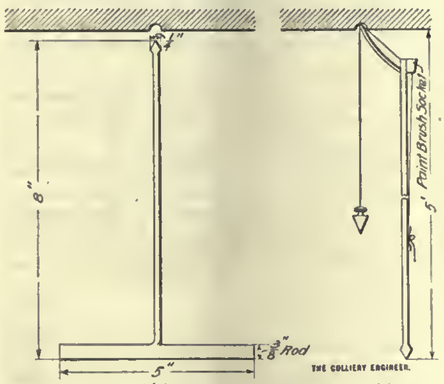


FIG. 1. DRILL AND ROD.

It is common practice with many companies to send three or four men to make a survey of underground workings but with the company in question this number is increased to five, each with a separate and distinct duty that promotes speed, accuracy, and efficiency in the work.

The corps to make the survey or "posting" consists of a transitman, first noteman, second noteman, foresightman, and backsightman. It is the transitman's duty to "set up" his instrument, take the sights and record the readings. The first noteman, with a 300-foot steel tape, stretches it along the line of sight between the stations (with the zero at the transit), and records the side notes as they are called out to him by the second noteman. He also makes the measurement between the stations. The foresightman selects the most advantageous position for each station, both as to extension and sound roof, puts in the station and gives sight. The backsightman assists the transitman to orient or "set up" his instrument, gives backsight, and holds the zero of the tape at the instrument when the first noteman measures his distance.

The equipment necessary, consists of a transit, 300-foot steel tape, side note rod, two sight rods, a brass and an iron plum bob, one 50-foot and two 25-foot tapes, tee drill, slope level or pitch rule, spads, twine, 2-quart oil can, white paint and brsuh, and transit and side note books.

The stations are all placed in the roof of the seam for permanence. They are made with the tee drill, Fig. 1 (*a*), except where the roof is so bad that it is found necessary to put a spad in a "collar" of a set of timber. In the latter case, where the timber is high, the foresightman puts a piece of twine through the hole in the spad and knots it, leaving it so that it will be within reasonable reach of the transitman when he attached his plumb bob to set up his instrument. Both sight rods are of the same design save that the one used by the foresightman has a heavy iron bob permanently attached to the cord on his rod. The backsightman uses the transitman's brass plumb bob which he attaches to the cord on his sight rod by a slip knot Fig. 1 (*b*).

Assuming station 100 already in place and the survey to begin at that point, the backsightman places the cord about the point of his rod and puts it in the station hole. By lengthening the bob string he lowers the plumb bob to the bottom rock, track, or whatever may be directly beneath, and marks a spot at the point of the bob with chalk. He then measures the distance from the spot to the station in the roof, which distance is immediately recorded by

the transitman. The transit is then "set up" over the spot. Then the bob is suspended from the station so that it hangs just above the telescope. This is for the exact orientation, which is effected by a simple shifting of the plate, due to the preliminary set up over the spot below. foresightman's cord he records the azimuth 180 degrees more than the reading on the plate. Then when he sets up at station 200 with his plate still fixed, he will sight back on the same course, and when turned to read the next foresight he will read the correct azimuth. Thus every

44 — Red Ash — Carter, Richards, Fry, Cox & Dorak | No. 37 Slope — April—1—1915 — 45

					204°03'		L.T. 6.04	
75 100–200	212°40'		+2°07'	48.91			L.T. 6.00	In Gw'y
200–201	142°07'		+3°04'	145.04			B 5.42	Up Cha.
							L.T. 6.09	
200–202	207°15'		−4.0 +1°05'	118.25			B 6.11	Face Gw'y
					142°07'			
200 201–203	148°26'		+3.2' +5°11'	125.60			B 5.73	Face Cha.
201–204	210°02'		−0°27'	52.41			L.R. 5.82	In Head'g
204–205	149°01'		+7°17'	92.08			L.T. 7.21	Up Cha.
204–206	212°14'		+0°18'	44.76			L.T. 6.14	Face Hd'g
					210°05'		L.T. 6.38	
76 102–207	208°16'		+2°13'	204.15			B 6.64	Face A'wy

THE COLLIERY ENGINEER.

Fig. 2. Transit Notes

This is especially advantageous in pitching places where it would take a great amount of time to set up below a bob. The transitman after setting the horizontal angle or azimuth at the reading (204° 03′) as recorded in the previous survey when station 100 was put in (from station 75 which is now the backsight), sights on the backsightman's string at the latter station. He then turns his telescope (not plunges) and sights at the foresight station. The continuous vernier is used reading from 0° to 360°, clockwise, the zero being at the south instead of the north as is sometimes the case.

The foresightman after making the new station hole with his tee drill paints a circle or triangle about it and also the new number (say 200). He then sets a spot directly underneath the station and measures the distance from that spot to the station above, calling it out at once to the transitman who records it as 6.00 L. T. (level with the tie) or 6.08 L. R. (level with the rail) or 6.25 B. (bottom rock or slate) whichever the case may be. After the transitman has sighted to the other reading in a continuous survey is 180 degrees out. In case of confusion the magnetic needle will indicate the proper reading. For instance, if the reading is 212° 40′, with the zero at the south that would mean N 32° 40′ E, but if it was a southwest course by the magnetic needle reading, the azimuth to be recorded is 32° 40′ or S 32° 40′ W. One of many advantages of the continuous vernier method is the accuracy of the reading. For example, after a sight has been taken ahead, the transitman picks up his instrument, after loosening the lower clamp or backsight screw, and proceeds to the new station, then after setting up there he can take his backsight without resetting the plate, thus avoiding a chance for an error. It is always advisable, however, to note the reading before taking the backsight, for, in case the instrument was bumped, the plate may have been slightly moved.

Returning to the original station 100. When the backsightman returns to the instrument after giving sight he measures the distance from the horizontal axis of the telescope to the "spot" below and calls it out to the foresightman, who shows a light at exactly the same distance above his spot. The transitman, with the aid of the horizontal cross-hair in the telescope, sights at the light, then reads and records the vertical angle. The foresightman gives the "elevation" called out to him by holding the ring at the end of his 25-foot tape on his "spot" and bending his tape at the distance called to him, this gives the transitman a horizontal line at which to sight. This procedure enables simple calculations for the elevations of the various stations, since a sight is taken at a point at the same distance above the track or "bottom" as the telescope is itself.

In giving sight, the point of the sight rod in the station should always be directed toward the instrument taking the sight except in the case of a pitching roof. In such instances the rod should be held at right angles to the pitch. When holding the rod over the instrument which the transitman is "setting up," it should point toward the foresight station. By following this procedure the bobs will always hang from the same point, thus eliminating probabilities of error.

When there is an obstruction encountered, such as a roll or swamp in the roadway and it is impossible to see the foresightman's lamp at the proper height for elevation, sight is then taken to a lower point as shown in the transit notes (Fig. 2) from station 200 to station 202. The elevation is taken at a point on the foresightman's tape 4 feet below the reading given to him by the backsightman as previously explained. Similarly, often when a car, door, or some such obstruction, is in the line of sight for a direct reading for elevation, it may be necessary to give "elevation" at a point on the tape above the proper height as in the survey from station 201 to station 203, where the sight was given 3.2 feet above the proper height. In such cases when the horizontal and vertical distances are calculated in the office, such variations are added or subtracted as the

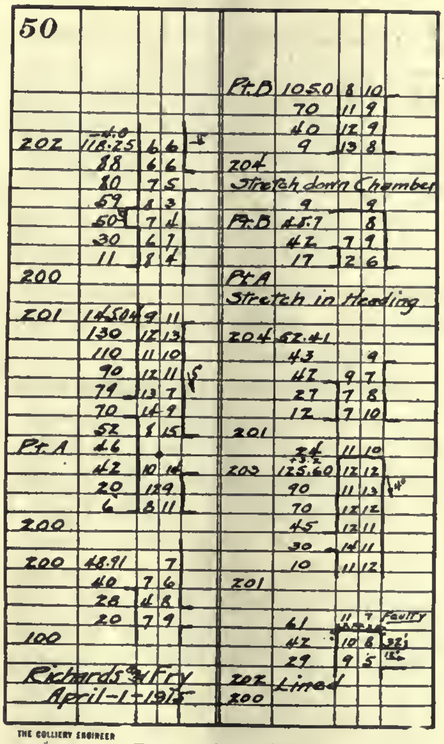
case may be. In the latter case, if the vertical distance is calculated to be 11.35 and that represents a height 3.2 above normal, the vertical distance is recorded as 8.15 feet.

The side notes are taken care of by the two notemen. After they have stretched the steel tape between the set up and the foresight station the second noteman takes his rod (usually of white pine, 7 feet long and 1 inch square in cross-section) and calls out the offsets from the tape line to the various openings, pillars, etc. Where the rib is solid and uniform for any distance, offsets every 20 feet are sufficient. In case of faults, sharp turns, etc., they are taken wherever necessary. Fig. 3 shows a page of typical side notes, as the first noteman records them. The second noteman on going from station 100 to 200, using his pole to estimate the offsets, would call out "plus 20, 7 left, 9 right rib outside; plus 28, 4 left, 8 right rib inside; plus 40, 7 left rib outside, 6 right; station, hole left, 7 right," etc. (see Fig. 3). Any other features are located in a similar manner. All such information is recorded and drawn at once by the first noteman.

When the notes for the line of sight are recorded, the measurement between stations is taken and recorded by both the transitman and first noteman. This completes the work for any particular "line of sight," except where "extensions" or "sections" must be taken.

"Extension" is resorted to in the case of station 202. Assuming the roof to be bad so that it will be blown down at a later day and hence is unsafe for a permanent point, the station 202 was placed in sound roof 61 feet back from the face of the working place. The first noteman takes his tape, with the zero at 202, and stretches it to the face, then by lining up with lights at stations 200 and 202 he will prolong the line of sight. Offsets can then be taken and recorded. When this is done with care the side notes will be as accurate as those from a transit line.

"Sections" constitute the recording of the thickness of the coal and refuse in the seam. They are usually taken at the face of every third or fourth chamber, depending upon the uniformity of the seam, and at the face of each gangway and airway, alternating at each quarterly



50					Pt.B	1050	8	10	
						70	11	9	
	40					40	12	9	
202	118.25	6	6	5		9	13	8	
	88	6	6		204				
	80	7	5		Stretch down Chamber				
	59	8	3			9		9	
	50	7	4		Pt.B	45.7		8	
	30	6	7			42	7	9	
	11	8	4			17	2	6	
200					Pt.A				
					Stretch in Heading				
201	145.04	9	11						
	130	12	13		204	52.41			
	110	11	10			43		9	
	90	12	11	5		42	9	7	
	79	13	7			27	7	8	
	70	14	9			12	7	10	
	52	8	15		201				
Pt.A	46					34	11	10	
	42	10	14		203	+3.2 125.60	12	12	
	20	12	9			90	11	13	4°
	6	8	11			70	12	12	
200						45	12	11	
						30	14	11	
200	48.91		7			10	11	12	
	40	7	6		201				
	28	4	8						
	20	7	9			61	11	7	Faulty
100						42	10	8	32°
						29	9	5	15°
Richards & Fry					202	Lined			
April-1-1915					200				

THE COLLIERY ENGINEER

FIG. 3. SIDE NOTES

posting. These sections are commonly recorded in the back of the side note book. They are used for tax estimate compensations, land values, etc.

Whenever the face of any working place is finished or the coal changes in pitch, it is recorded by the notemen. They also measure the inside rib of all cross-cuts (Fig. 3). This will roughly check the side notes and survey of the adjacent working place.

In surveying a tunnel it is important to note the point where the coal ends at both top and bottom and where it begins at the other end. By the system of indicating tunnels, and using this information, the map will show at a glance the pitch of the seams.

The backsight courses used are recorded by the transitman and are shown in the transit notes, also the roof distance of the old station where the new survey begins.

Putting Up Line Spads.—All lines for driving working places are set from stations. The lines are fixed by spads driven in wooden plugs in the roof.

Two men constitute the corps for this work, usually a first noteman and a backsightman or foresightman. The center lines of the chambers, gangways, airways, slopes, etc., and their courses show on a blueprint of the workings, and with these as a guide the lines are set. By setting up the transit at a station nearest the lines to be put up, the distance to the proposed room is measured off, one spad put up and sighted to, the azimuth and distance noted and then the transit set up under that spad. With the station for the backsight the second spad is put up. In some cases they may be put in on line from the station. Fig. 4 shows typical spad notes.

Where slopes, gangways, airways, chamber lines along barrier pillars, etc., are so far back from the face that the miner can no longer extend them by eye, the transit should be used to extend these lines. Setting lines from new stations nearer the face in such cases should be discouraged, as the possibility of error increases. In chambers of pitching seams it is customary to set the lines so they will be in the traveling way of the chamber, for

Station	Azimuth	Needle Reading	Distance	Remarks	
	No. 9 Slope, Baltimore Seam				
289 290—sp'	312°10'	S 50° 00' E	42.5		In gangway
sp'—sp'	247°30'	N 67° 00' E			Cha. 25—Road 100
204 216—sps	247°30'	N 68° 00' E	On line		Cha. 21—Road 101

Fig. 4. SPAD NOTES

convenience. In flat places, care should be taken to avoid putting them near the brattice or props, for then the miner will have difficulty in getting his point.

Where it is inadvisable or impossible for some reason to set up the transit in extending lines, they may be extended with great accuracy with the eye by the following method:

Weight both strings so that a definite line is possible and at a point on line 8 or 10 feet from the face of the working, have another spad driven in the roof. When after checking the location of this spad so that it is known to be right on line, let the foresightman go 3 or 4 feet nearer the face; then by suspending his plumb bob, he can line it in with the spad already in place and a light behind one of the old spad strings. This done with care insures a continuance of the line with fair accuracy.

After returning to the office the locations of the new lines are calculated and the proper right and left for each pair sent to the superintendent of the mine. All center lines are carefully followed; for example, if the lines are located 4 feet to the left of the center line, and the chambers are 24 feet wide, the advice would be sent to drive the chamber "8 feet to the left and 16 feet to the right of that line."

Efficiency of Air Compressors

The effect of altitude on the efficiency of air compressors is considerable. The calculation of the volume of compressed air delivered at sea level and at higher altitudes may be shown by the following example:

If we have 300 cubic feet of air at an atmospheric pressure of 14.7 pounds per square inch, and compress this air to a gauge pressure of 80 pounds a square inch, the volume will be $300 \times 14.7 \div (80 + 14.7) = 46.5$ cubic feet. If the air is at an atmospheric pressure of 10.1 pounds per square inch, then the volume will be $300 \times 10.1 = 35.5$ cubic feet. The volumetric efficiency of a compressor at 10,000 feet above sea level is, therefore, only 72 per cent. of what it would be at sea level.

The Carlisle Mine Explosion

By W. Z. Price

A miner going into a room which was marked "Dangerous," caused his death and that of twenty others on February 6 at the Carlisle mine of the New River Co., at Carlisle, W. Va.

The explosion occurred at 7:45 A. M. only 15 minutes after starting time, in what is known as the fifth left entry which is turned off the third right main.

From what may be gleaned from the testimony of the fire bosses, Romeo Campi and John H. Riley, gas was discovered in No. 11 room, but showed only a ¼-inch cap on the flame of their safety lamps. However, they marked off that room as dangerous, both at the entry and at the last breakthrough between No. 10 and No. 11. It appears that Fred Pannell, whose body was found in that room, went into it for some unknown purpose and ignited the gas. In all, 20 men were instantly killed and five injured, one of whom died later.

Since there was no interruption in the ventilation, it is unreasonable to believe that sufficient gas could have accumulated since the fire bosses' examination at 6 o'clock, less than 2 hours previous.

The rescue work was carried on under the direct supervision of General Manager Scott, who, with the aid of the fire bosses, the mine foremen, and superintendents from adjoining mines, succeeded in removing all the bodies by 6 o'clock that evening. The live stock was loaded and taken outside later the same night.

State Mine Inspectors Holliday and Absalom were on the ground shortly after noon and the United States Bureau of Mines rescue car arrived on the scene about 2 A. M. the next day.

Probably the most significant feature about the explosion is the great loss of life from such an apparently small quantity of gas. The property loss in this case was negligible.

The coroner's jury at the inquest four days later rendered the verdict that the "above-named persons came to their death on the 6th day of February, 1915, by an explosion of gas in the Carlisle mine, and we do further find that there was no evidence showing or tending to show any negligence or failure to perform its duty, on the part of the White Oak Fuel Co. operating its mine, and that the said White Oak Fuel Co. furnished all necessary supplies of all kinds and gave to the mine foreman and the mine bosses the necessary instruction to keep the mine in safe condition; and we further find that if there was any negligence that it was due to the failure of the fire bosses in not marking up on the side of the mine that there was a small amount of gas in room No. 11 on fifth left although he had marked the said room as dangerous at this entrance."

After proper investigation by the State Mining Department of West Virginia, warrants were issued for the arrest of Mine Foreman Pilkington and Fire Bosses Campi and Riley. The charge was negligence in connection with the explosion.

At the trial before Justice of the Peace Samuel Jasper, the fire bosses were fined $50 each. Their certificates were revoked as was also that of Pilkington, by the State Department of Mines. Pilkington was not convicted at the trial. He admitted on the stand that on the morning of the explosion he had failed to examine the record books of the fire bosses, and also the bulletin board. He had also allowed the miners to enter the mine without making an examination. For this reason his license was revoked.

Chief of Department Earl Henry declared that all persons neglecting to perform these duties when required by law will have their certificates revoked.

The Testing of Ventilating Fans

With Special Reference to the Measurement of Pressure. Influence of Position of the Water Gauge on Reading

By Thomas Bryson, A.R.T.C. (Glasgow)*

PAPERS of a similar character to the present have already appeared in the Transactions of this Institute. It may seem necessary, therefore, that some explanation should be offered to justify another paper on the subject. The writer believes that a perusal of papers dealing with the question will show that the proper method of determining the mechanical efficiency of a ventilator is a matter of considerable doubt, on account of the uncertain results obtained in recording the ventilating pressure by means of the water gauge in one or other of its many forms. If "mechanical efficiency" is to be a term of any real value when applied to a fan, it will surely be necessary that every factor in the expression should be correctly determined. The determination of the brake horsepower of the driving engine or motor presents no difficulty, nor does the measurement of the volume of air dealt with by the fan. The exact determination of the height of the water gauge is a much more troublesome matter at present; indeed, there is no generally accepted method of measuring the height of the water gauge. Gauges are made of different shapes, and are placed in different positions in the fan drift, both with respect to the direction of the air-current and to the ventilator.

It is certain that the height of water gauge registered will be affected by the position and form of the gauge and by the velocity of the air in the region of the gauge. Then, there is always the error of reading, which can never be eliminated. With regard to these remarks, reference may be made to Mr. Mowat's admirable paper,† in which the author states that—

"It was found that the measurement of the water gauge by a plain tube at No. 4 was absolutely unreliable, the readings varying as the tube was moved from one side of the drift to the other. With a Pitot tube at No. 4 the readings were the same from side to side of the drift. ...The writer is satisfied that the results obtained with the Pitot tube are quite reliable."

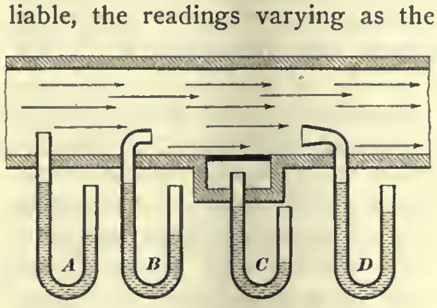


Fig. 1

The writer also desires to direct attention to a paper‡ by Mr. John Watson, in which the author shows several forms of water gauges, and states:

"The diagram, Fig. 1, shows several styles of water-gauge tube terminations in the fan drift, the most usual form being *A*. With this form the real water gauge is not obtained, except when the velocity is small; as with a high air velocity the current causes a sensible reduction of air pressure in the gauge tube, and a consequent increase in the height of the water column. This may be quite a substantial amount, and may spoil an otherwise carefully-made test. *B* is another form of water gauge tube termination, *C* yet another form, and *D* is, in the writer's opinion, the correct form. It is used entirely to eliminate the velocity factor, and register exhaustion only."

It is probable that the majority of serious students of the subject will support the opinion expressed by Mr. Mowat, while some will maintain that the ventilator should be credited with the total water gauge registered by a plain tube. There are others, however, who do not agree with Mr. Watson that *D* is the correct form of water gauge, or that it will eliminate the velocity factor and register exhaustion only. In consequence of the complications arising from the use of so many types of water gauges, this Institute might with advantage address itself to the determination and specification of the most satisfactory form of gauge. The writer believes that after a study of the basal principles and careful experiment, the specification of the most satisfactory kind of water gauge, and the position of the same, would present no serious difficulty.

The Conservation of Energy in Relation to the Measurement of Pressure. It is a well-known physical truth that energy, like matter, is indestructible, although under the influence of some external agent its form or state may be changed. If the significance of the preceding statement be properly grasped, the whole question of the measurement of pressure will be rendered comparatively simple; in fact, it will be shorn of the anomalies with which it is said to be inseparably bound. The anomalies appear to the writer to be a consequence of the treatment of the subject—not part of the subject itself. The theorem of Bernouilli states that, if a liquid flow in

*Transactions of The Mining Institute of Scotland and The Institution of Mining Engineers.

†"Facts and Theories Relating to Fans," by David M. Mowat, Trans. Inst. M. E., 1912, Vol. xliv., page 92.

‡"The Testing of Fans: A Plea for Standardized Test Conditions," by John Watson, Trans. Inst. M. E., 1913, Vol. xlv., page 403.

a closed channel, the channel always being full, and the friction of the fluid against the sides of the conduit being neglected, the total energy in a unit mass of the fluid remains constant, that is

$$P+\frac{V^2}{2g}+H=\text{constant}$$

where

P = pressure in pounds per square foot at any point on the wall of the conduit;

V = velocity of the fluid at the point, in feet per second;

H = height of the point in feet above some selected datum plane.

With reference to the channel of varying section shown in Fig. 2,

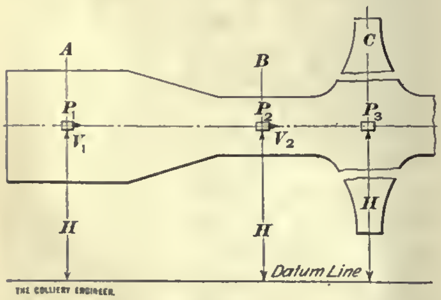


Fig. 2

consider the unit mass of a fluid at the instant when it enters the section at A, at a height H above the selected datum plane. The unit mass of the fluid will possess at that instant a certain amount ($V_1^2 \div 2g$ foot-pounds) of kinetic energy in virtue of its velocity; and a certain amount (H foot-pounds) of potential energy on account of its elevation above the plane of reference. The pressure on the wall of the channel may be called P_1. If the unit of mass of the fluid be again considered when it has entered another and smaller section at B, the kinetic energy ($V_2^2 \div 2g$ foot-pounds) will be greater than at A, because of the increased velocity; and the potential energy will be H foot-pounds, as before, since the unit mass is considered to be moving in a plane parallel to the plane of reference. The pressure on the wall of the channel may then be called P_2 pounds per square foot. Now, since the total energy in unit mass of the fluid is constant—

The total energy at A = the total energy at B; that is,

$$P_1+\frac{V_1^2}{2g}+H=P^2+\frac{V_2^2}{2g}+H$$

But H is of constant value, and V_2 is greater than V_1; therefore, the pressure on the wall of the conduit at A is greater than that at B. Consider also the state of the element or fluid when it has reached the section C, which is supposed to be of infinite area. The velocity is there reduced to zero, in consequence of which energy in the kinetic form will have disappeared, and the pressure P_3 at that section will be greater than the pressures P_1 and P_2.

It appears to the writer that the following questions are consequential to the foregoing considerations, and it is his desire that a serious attempt should be made to answer them satisfactorily, in the discussion which may follow the reading of the paper.

1. If, as has been emphatically stated in discussions on other papers in the Transactions, the Pitot tube is the correct form of water gauge, would tubes fitted at A and B register the same depression; or, if such a tube be moved from side to side of a fan drift in which the velocity of the air-current is not uniform over the whole section, would the pressure registered be constant over the whole section?

2. If the pressure at A is not the same as at B, and the pressure is not constant over the whole section of the fan drift, which pressure is the correct one?

3. If neither pressure can be considered as correct, how may the correct pressure be measured?

The Position and Form of the Water Gauge.—In calculating the "mechanical efficiency" of a ventilator, the numerator of the fraction is invariably taken to be the horsepower in the air just at the entrance to the fan.

It is generally agreed that the water gauge should also be measured at the ear of the fan; but there is nothing in the nature of unanimity with regard to the precise position of the water gauge. If D, Fig. 1, is the correct form, it may be placed anywhere near the fan, even in the ear of the fan; but if C is considered the better form of gauge, it might be most conveniently placed near the ear of the fan on the wall of the drift. If a gauge be placed in the ear of the fan, error is bound to arise from varying velocities due to eddy currents; but if a gauge of form C be placed on the wall of the drift near the fan, and separated from the drift by a partition in which there is a capillary connection, it is most unlikely that the pressure registered will be affected by air-currents, since the interior of the box would be a zone of reduced pressure, in which there would be no appreciable movement of the air. The condition of the air in the box would be quite the same as that of the air at section C in the drift, Fig. 2, and consequently a gauge of the ordinary form fitted to such a box would register exhaustion only.

Experiments.—The writer has recently made some experiments to test his conclusions with regard to the various forms of water gauges, and the data embodied in this paper are typical of the results obtained.

Experiment No. 1 was carried out for the purpose of determining what pressures would be registered by gauges of the forms A, B, C, and D, attached to the fan drift, when no

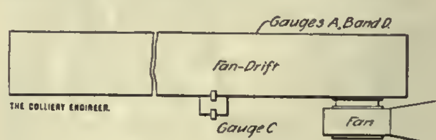


Fig. 3

air was allowed to pass through the fan drift, it being closed at the end.

Table 1 shows the results obtained for a number of speeds of the ventilator; whilst Fig. 3 shows the

Table 1. Results Obtained From Running the Ventilator at Varying Speeds

Revolutions per minute..	1,730	1,840	2,000	2,190	2,260
Type of Water Gauge	Water Gauges, in Inches				
A	3.47	3.95	4.45	5.15	5.80
B	3.47	3.95	4.45	5.15	5.80
C	3.46	3.92	4.44	5.13	5.77
D	3.45	3.93	4.45	5.13	5.77

relative positions of the fan, fan drift, and water gauges.

Experiment No. 2 was intended to establish a relationship between gauges of the forms A, B, C, and D for different velocities of the air passing in the drift. During the experiment a constant opening was maintained at the end of the drift, the change of velocity being obtained by altering the speed of the ventilator. Table 2 records the results obtained. The "head of water" h due to velocity has been calculated and tabulated. The relationship between the values of C and $(A-h)$ are exceedingly interesting.

Table 2. Showing the Relationship Between the Velocity of the Air and the Pressures Registered on the Gauges A, C, and D

Velocity of air, in feet per minute	1,645	1,780	1,935	2,100
Type of Water Gauge	Water Gauges, in Inches			
A	.43	.50	.60	.70
C	.27	.30	.37	.42
D	.20	.25	.30	.34
h	.17	.20	.22	.29
$(A-h)$	.26	.30	.38	.41

In Fig. 4 the different pressures have been plotted against corresponding values of velocity.

In carrying out experiment No. 3, pressures were registered over a greater range of velocities than in experiment No. 2, and the opening at the end of the drift was varied in order to enable a series of "equivalent orifices" to be obtained. Table 3 is a record of the data obtained during the experiment, and the values of the equivalent orifice which have been used as abscissas in drawing the curves are shown in Fig. 5.

Conclusion.—At the conclusion of the discussion of the purely theoretical aspect of the question, it appeared that at least three forms of tube terminations, namely, A, B, and D, were not scientifically correct.

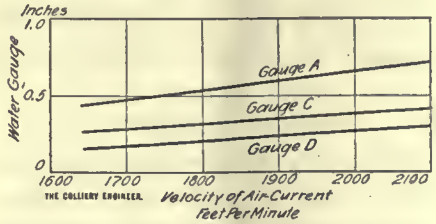


Fig. 4

It was shown that the value of P_3 at section C, Fig. 2, would be greater than either P_1 or P_2 at sections A and B, respectively. The experiments also show that the pressure registered by a water gauge situated in a zone of reduced pressure, separated from the fan drift by a partition having a capillary connection in it, is greater than the pressure registered by a Pitot tube.

There is little difference, however, between the readings given by C and D when the velocities are small; but there is a considerable difference between them in the last column of Table 3.

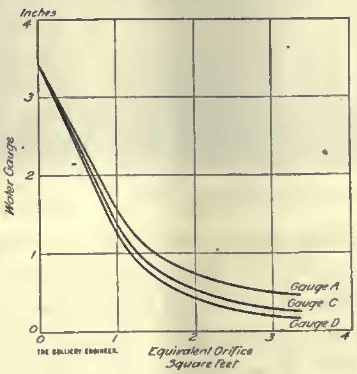


Fig. 5

When regarded from the practical standpoint, Mr. Mowat's use of the words "quite reliable" may be justified; indeed, Table 3 shows how far the results obtained by a Pitot tube are reliable. But one must distinguish between a mere expression of opinion and a scientific truth, and in doing so carefully examine the evidence from which the truth has been determined. The whole of the evidence in the present paper is in favor of a water gauge of the form C as may be judged by comparing the values of C and $(A-h)$ in Tables 2 and 3.

Table 3. Results Obtained From Running the Ventilator at Varying Speeds on a Varying Opening in the Fan Drift

Revolutions of fan per minute	1,730	1,520	1,300	1,240	1,190	1,120	1,090	1,050	1,000	980	960
Type of Water Gauge	Water Gauges, in Inches										
A	3.48	2.79	2.30	2.03	1.67	1.26	1.00	.80	.58	.15	.42
C	3.48	2.72	2.22	1.95	1.57	1.15	.85	.65	.42	.28	.25
D	3.48	2.70	2.20	1.90	1.51	1.05	.80	.50	.30	.20	.18
h		.01	.05	.07	.09	.11	.12	.14	.15	.16	.16
$(A-h)$	3.48	2.78	2.25	1.96	1.58	1.15	.88	.66	.43	.29	.26
Velocity of air, in feet per minute		580	940	1,045	1,175	1,300	1,400	1,500	1,540	1,580	1,600
Quantity of air, in cubic feet per minute		1,300	2,110	2,350	2,640	2,920	3,150	3,375	3,460	3,550	3,600
Equivalent orifice, in square feet		.30	.55	.67	.83	1.11	1.38	1.88	2.45	3.14	3.34

Advice of the Lackawanna Safety Committees

Think "Safety First," and act "safety" always.

Preach "Safety First" and practice what you preach.

Be sure you are safe, then go ahead; the man who thinks before he acts avoids accidents.

An ounce of prevention is worth a pound of cure.

Looking out for the other fellow makes it safe for every one.

To be careless, thoughtless, or reckless means injury, sooner or later, to yourself and others.

Accidents are almost inevitably some one's fault—don't let it be your fault.

Don't meddle with electrical apparatus. Call the electrician.

Don't take a chance; the safe way is always the best and quickest way.

The more you insist upon carefulness on the part of others, as well as exercise it yourself, the safer it will be for all.

Personal caution is the greatest of all means of preventing accidents.

"Safety First" is first aid to the uninjured; the injured are taken to the hospital.

Think of yourself, and the doctor won't have to think of you.

Remember it is better to cause a delay than an accident.

If you see anything wrong or dangerous, it is your duty to report it to your foreman at once.

Stop! Look! Listen!

A French Electric Mine Hoist

Devices for Obtaining an Equalization of the Power Absorbed at Different Stages of the Hoist

Written for The Colliery Engineer

IN FRANCE the application of electric energy to colliery practice has produced some interesting electric power installations. At the Landres mines of the Societe des Acieries de Micheville is to be found a fine example of an electric winding engine constructed by the Societe Alsacienne de Constructions Mecaniques of Belfort. Generally,one of the two shafts required by law serves for the winding and for the introduction of air, the other for the return air and all secondary services such as dealing with workmen, material, etc. The Landres mines desiring to profit in the use of its second pit by securing, in addition to these secondary services, a greater capacity for winding, decided to have a second hoist at this shaft ready to operate in case of accident at the principal shaft. In addition to the advantages ordinarily obtained by electric operation certain special circumstances conduced to the adoption in this installation of an electric winding motor rather than a steam engine. The establishment of powerful electric drainage pumps, becoming from day to day more necessary because of the increase of water, gave room for the consideration of an augmentation of power at the central station. A new unit therefore became necessary which must run without stop in order that uninterrupted drainage could be assured. This unit was designed say for 1,000 kilowatts as the actual requirements to which about 500 kilowatts more was added for eventual drainage needs. This power represented more than four times the mean power demanded by the winding machine. The price of electric generating units increases more slowly than their power and there was therefore every advantage in installing a plant a little larger than was at the moment absolutely necessary, as it was able to assure at the same time the feeding of an electric winding engine. The cost of installation in this way was reduced to very little more than the price of the hoister alone, as the cost of the generator was spread over the other installations supplied. As the generator would be continually under a considerable load, the fluctuations produced upon it by the succession of periods of running and stopping of the hoister would be less apparent. Under these conditions it became rational to adopt an electric hoister instead of steam engine.

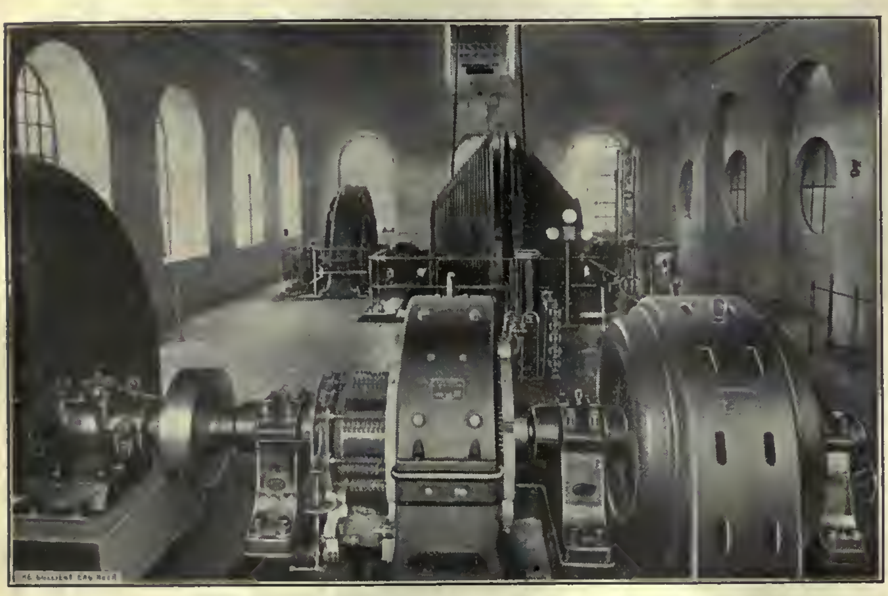


Fig. 1. A French Electric Hoist and Converter Set

This machine was constructed to fulfil the following requirements: Normal depth of wind, 755 feet; useful load (mineral), 3 tons; single stage cage (one car per cage) weight, 3¾ tons; weight of empty car, 1,800 pounds; round-steel rope, diameter, 1.5 inches; round-steel rope weight per meter, 10.8 pounds; number of winds per hour, 90; total time of a wind including handling the car, 40 seconds; time of wind, 30 seconds; time for handling cars, 10 seconds.

The realization of the program of winding presented particular difficulties because of the great number of winds per hour. Also, direct operation by a three-phase motor was rejected, as the small depth of wind and the frequency of stops made this solution uneconomical. It was decided to employ for the winding motor the continuous current machine fed by the converter set shown in Fig. 1. In this system the winding motor, which has independent and constant excitation, is fed at a variable pressure by the generator of the converter set, this variation of the pressure on the terminals of the motor having for its object the starting, variation of speed, the braking, and the alteration of the direction of running of the winding

motor. This is obtained by acting on the excitation of the generator. A simply built rheostat with a reverser operated by a lever is sufficient to effect all the maneuvers. This system is preferable, because by the direct drive of an asynchronous motor, at each position of the operating lever there is a definite pressure of the generator dynamo and therefore a practically constant speed, for the winding motor, whatever its load within ordinary limits. It follows, therefore, that at the moment of reducing speed, or during the lowering, the winding motor acts as a generator and restores to the converter set the amount of energy provided by the diminution of the stored energy in its moving masses. Hence, quite automatically and very advantageously from the point of view of consumption, electric braking is accomplished. There is therefore security in running, and moreover it is very easy to provide safety arrangements. As the central station would have difficulty with the frequent starts of the winding motor and the fluctuation of power which would result, a system was adopted that allowed the equalization of the power absorbed. For this purpose a flywheel is coupled to the converter set, and stores during the stops the available energy and restores it during a period of working. The converter with its flywheel serves therefore as a buffer between the central station and the winding engine.

In winding, cylindrical drums have the inconvenience of giving a variable resisting couple, decreasing from the commencement to the finish of the winding, because of the difference of weight in the rope, therefore it was decided to use truncated cone drums which allow the maintenance of a resisting couple of a practically constant value, and for this reason also a similarly constant current in the motor and generator. The drums adopted had the following features.

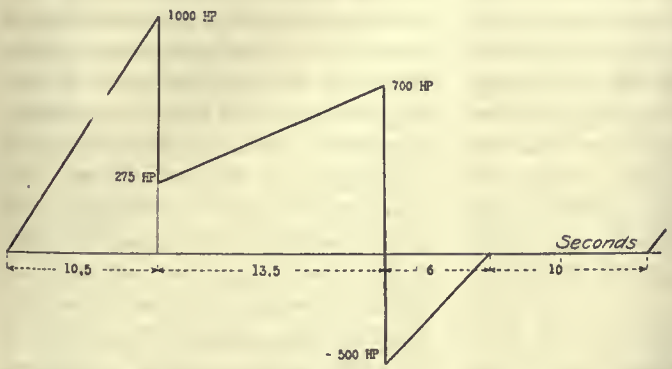


Fig. 2

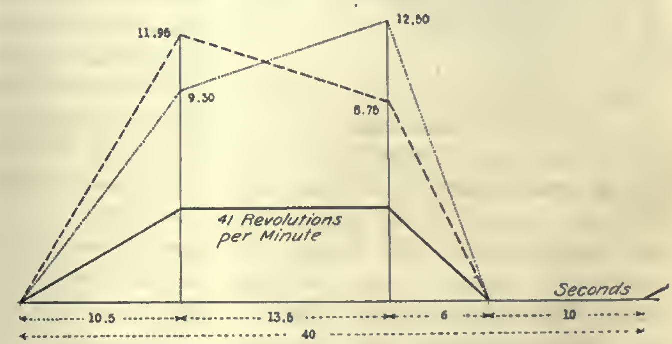


Fig. 3

The extreme diameters for new cables are 3.75 meters and 6.15 meters. The minimum useful diameter for worn cable is 3.5 meters. The number of turns of rope on the drum between the diameters 3.75 and 3.5 allow for cutting the used parts of the rope. In proportion as the length of the rope diminishes, the useful diameters of the drum decrease, arriving finally at 3.5 meters and 6 meters when the cables are completely unwound. The number of turns between 3.5 meters and 3.2 meters allow the lower cage to descend below the lower loading point. During this time the upper cage is raised above the upper platform and the cable winds on the turns included between the diameters of 6.15 and 6.35 meters. Finally the turns between the diameters 3.2 and 3 meters are the dead turns necessary to assure a secure hold of the cable on the drum. With these drums and under the conditions of running the operating diagrams shown in Figs. 2 and 3 were obtained. In Fig. 3 the thick full line shows the revolutions per minute of the motor shaft. The thick dotted line shows the curve of linear speed in meters per second of the cage when rising, while the thin dotted line shows the speed of the cage in lowering.

The drums are of sheet steel carefully assembled; each of them can be put into action for the adjustment of the ropes and held by a brake operated by a hand wheel acting on a special rim. They can be fixed solid with one another by a screw system which allows an absolutely exact adjustment of the cables. The access to the inside of the drums is easy and allows of their cottering and the attachment of the cables. The shaft of Martin steel terminates at one end in a forged half-coupling for attachment to the shaft of the motor.

The brake disks are solid with each drum and receive the double jaws of a brake whose linkwork is operated from below. The brake is operated by compressed air, by the operating brake cylinder or by the safety brake cylinder. The former is horizontal direct acting, the latter being vertical with a counterweight. The brake operates as a maneuvering brake to produce a stop or to slow down the load before stopping. The air pressure on the piston of the horizontal cylinder produces a closing of the brake. The brake when operated by the safety gear is released by a counterweight normally supported by compressed air under the piston of the vertical cylinder. This counterweight in its fall produces the closing of the brake. The safety brake operates in the following cases: (*a*) When the compressed air is lost. (*b*) When

the cage passes the loading stage by a certain amount, the position indicator then producing disengagement by means of an appropriate lever system. (*c*) By hand by means of a lever in case of non-operation of the operating brake. (*d*) By means of a solenoid, whose core is normally kept raised by the 500-volt exciting current supplied from the central station. If this current is cut off, the core of the solenoid falls and allows the drop of the counterweight of the safety brake.

This operation can be produced in the following cases: (1) When the 500-volt current of the general system which feeds the exciting circuits of the generators and motors fails. (2) When the automatic cut-out of the principal circuit of the motor opens; this cut-out is furnished for the purpose with an auxiliary cut-out which opens the exciting circuit of the solenoid. (3) If there is excess speed of the cages in the pit. For this purpose the registering apparatus is furnished with an auxiliary contact which by means of a relay breaks the feeding circuit of the solenoid if the speed passes a certain value. (3) When the cage passes the landing points, cut-outs placed on the position indicator at the end of the normal travel of the index again open the solenoid circuit. The fall of the safety counterpoise has in addition the effect of cutting off the excitation of the generator. In this way the winding motor is not fed while the brakes are closed. The compressed air necessary for the operation of the brakes is furnished by a small electrically driven compressor. Its three-phase motor is furnished with a coupling which comes into operation by centrifugal force when running speed is reached. With a pressure variation below 5 kilograms a pneumatic relay closes the switch of the motor circuit. The motor is cut out of circuit in a similar manner when the pressure exceeds 7 kilograms.

At the driving position are two operating racks, one for the lever acting on the field resistance, the other for the brake lever. The position indicator has two travelers guided by two vertical posts and operated by two endless screws which in turn are driven by the shaft of the winder by means of an intermediary shaft and pinions. This position indicator is furnished with a speed reducing device to guard against inattention on the part of the operator. For this the traveler corresponding to the rising cage makes contact at a given moment with a pedal which by means of linkwork raises the operating lever to about the stopping position. If afterwards the operator does not effect complete stoppage at the moment that the cage arrives at its proper stopping point, the index acts on another pedal which operates the safety brake.

The motor is placed on the shaft of the hoister between one of the drum bearings and an external bearing. The motor is fed at a pressure varying from nothing to ± 500 volts. Its speed therefore varies between zero and 410 revolutions per minute in either direction and the power developed from nothing to 1,000 horsepower in accordance with the diagram given above. It is furnished with auxiliary poles which make the commutation perfect and without sparking at all loads and speeds. The fields are fed by the general 500-volt supply from the central station. The excitation is constant during all the time of running, but when stops are made an additional resistance placed on the operating gear is automatically introduced into the field circuit by means of which the losses are reduced very considerably. The flywheel converter set contains a generator, a motor, and a flywheel. The motor is an asynchronous three-phase kind fed by the 3,000-volt, 50-period system. It is capable of giving in ordinary running a power of 450 horsepower, its speed being then 485 revolutions per minute. The set is completed by a flywheel driven by the electric machines through a semielastic coupling. It is of cast steel of a single piece weighing 15 metric tons;* its peripheral speed is 90 meters per second, and it is capable of storing energy to the extent of about 3,500,000 kilograms. This flywheel is calculated to furnish, as the result of a drop of speed from 485 to 410 revolutions, the supplement to the energy which it is necessary to take from the central station during the moment when the power absorbed by the winding engine exceeds the mean power until the moment that it returns to below the mean value. Inversely, the flywheel absorbs during the stopping times the energy previously liberated and its speed rises again to 485 revolutions. In this way the power absorbed by the asynchronous motor remains constant. To obtain the variation of speed allowing the energy of the flywheel to be utilized, the resistance of a regulating rheostat is inserted automatically in the rotor circuit of the asynchronous motor by means of a regulator. This same rheostat serves for starting the motor generator set. To reduce to a minimum the friction losses of air, which are far from being negligible with the peripheral speeds employed, the flywheel is completely enclosed in a sheet-iron case. The bearings of this flywheel are cooled by water circulation. In order to start the set, a hand pump is used to force oil under pressure into the bearings. A brake operated by a hand wheel is used to stop the set.

An interesting feature of this installation consists in the possibility of directly feeding the winding motor from one of the continuous-current generators at the central station in case of accident to the converter set or should the three-phase current fail. The operation of the winding engine can be continued provisionally in the following manner. The central station contains two electric generating sets each consisting of a compound steam engine running at 110 revolutions per minute coupled to continuous-current generators

*$1.102 \times 15 = 16.53$ tons.

(*Continued on Page 511*)

Importance of Good Mine Tracks

Method of Building and Caring for Tracks Underground. Economy of Using Boiler Ashes for Ballasting Mine Roads

By J. C. Edwards*

MINE tracks being necessary for successful haulage, their condition is of consequence, and while considerable progress has been made, during the last 15 years, toward the betterment of mine tracks in general, the subject is one that invites more serious thought and attention than has been given it by mining men.

The bituminous coal mine tracks of 15 or 20 years ago, consisted of 20-pound rail on slope tracks and 16-pound and 12-pound on the butt headings. In most of our mines of today, classified as "up to date," 60-pound rail is used on the main haulage, while 40-pound rail is used on the butt headings, and instead of the old wooden rail, that was used in the rooms of years ago, the 16-pound rail is now used. This increased size of rail seems to be the greatest progress that has been made. If heavy rails are essential to successful mine haulage, so are proper gauge, alinement, grade, ballast, and surfacing. In the matter of these important factors material progress has not been made, because mining men have been indifferent regarding detail. It is a concrete fact that a mine track constructed with the proper size rails with ties properly spaced and spiked, with good alinement and grades, and ballasted with ashes, will not only materially affect the haulage, but will also require less attention and expense for repairs; and with this fact established, these details should be given more attention.

If some of the mine tracks were reproduced on the surface, their alinement would be a surprise, and the wonder would be how the motormen and drivers haul as much coal over them as they do.

In constructing a track on the surface, particular attention is paid to the gauge and the alinement, and grades are made favorable to the motor. Most mine tracks are constructed indifferently. If the gauge is half-inch full, "Oh! That is close enough for practical purposes; better the gauge be a little full than tight." If a tie is split in the spiking, "Let it go. No one will ever notice it, as it will be covered up directly." "Yes, that is good enough for line," you will hear the trackman say. The mine foreman inquires whether the piece of track in question has been put in; he is told by the trackman that it has, and so long as the driver or motorman gets over it, it is all right. No more attention is given the matter, until a wreck occurs at this point, when it is discovered that the rails have spread, owing to one or more split ties. The trackman is ordered to replace these split ties; and so it goes from day to day, and that is the general caliber of mine tracks.

There is no good reason why these conditions should exist. There is no good reason why a mine track could not be laid straight, true to gauge, and properly ballasted and surfaced with non-combustible material. A few years ago I visited a certain mine to examine a rope haul. When traveling along the main motor haulage road, the mine foreman called attention to the 60-pound rails that were used in this track. In walking along, a number of split ties were noticed, due to the improper spacing of the spikes. I inquired of the mine foreman, if they had wrecks on the road due to the spreading of the rails, and was informed that they had wrecks once or twice a month. A little further along, the motor was approaching and I had an opportunity to observe the track alinement—which was frightful. Had a little more attention been given to a better class of track work these wrecks would have been avoided. The alinement should have been good, as the center line of the heading had been given by the engineer.

While serving as an engineer I paid particular attention to mine tracks, and to get alinement I instructed the transitman to put in enough points for the trackman to line up his track properly. We found the most difficult portion of mine tracks to be the curves. Usually the trackman, in looking over the place where a curve is to be put down, sizes up the approximate location of the frog, and it is so placed that the usual result is either a flat curve or a sharp curve. To overcome this difficulty I had the radius painted on the rib; the P. C. and first 10-foot chord were plainly marked on the roof. I furnished both the fire boss and trackman with a small blueprint, of a size that could readily be pasted on the inside cover of a time book. This print was for 50-, 60-, 75-, 100-, and 150-foot radius curves and contained the following data for the different radii: Offsets, based on 10-foot chords; length of curve; offset for decimal part of curve, necessary to get heading on tangent; number of frog; distance from P. C. to point of frog.

In this way, the fire boss, after a little instruction as to the use of offsets, was able to produce the proper curve, without the assistance of the engineer. The trackman was able

*Allison, Pa.

to ascertain the number of frog, as well as its exact location. Previous to the time when shop frogs came into general use, I also furnished the trackman with a print showing the exact length of lead rails and switch points, which enabled him to have his switches all ready, before being sent into the mine, thus saving valuable time, in laying the switch. The blacksmith was furnished with a print of the different sized frogs, so that all the frogs were made uniform. The improvement that was shown in the track work was surprising after the fire boss and trackman realized just what was expected of them.

However, after placing the tracks in their proper position, there is the important work of ballasting and surfacing to do. If this part of the work is slighted, all that has been done goes for naught. In choosing material for this purpose two qualifications are to be considered: (1) Ballast material should have sufficient packing qualities to hold the track in position. (2) The ballast should be non-combustible.

Of these specifications, the first is necessary to keep the track in its proper position, form a compact roadbed, and yield a minimum amount of dust from traffic. The second is a factor of safety.

Much has been written, relative to the merits of rock dust on a series of shelves, placed in the different butt headings throughout the mine, to lessen the chances or to eradicate the possibilities of a general explosion. However, little has been said or done toward using a non-combustible material for ballasting and surfacing mine tracks. It is self-evident that unless haulage roads are kept clean and free from the coal that almost continually falls from mine cars, there will be an abundance of material, ground and pulverized by traffic to such an extent that particles of combustible coal dust will float in the air. This dust is a menace to the safety of the mine. Should an initial explosion occur in a portion of the mine where these dust particles float in the air-current, they would add to the force of the explosion.

Boiler ashes which are legitimate waste at every coal mine using fuel for steam purposes, have both the required specifications for a good roadbed. However, up to the present time but few of the so-called up-to-date plants are using this waste for mine track purposes.

A number of years ago, shortly after the sprinkling system came into use, there was a discussion between a state mine inspector and a mine superintendent relative to the merits of sprinkling working faces previous to shooting, also to the sprinkling of haulage roads. At the time of this discussion, the mine superintendent was ballasting his haulage roads with coal, and this, too, in a mine that was generating firedamp freely. The firedamp in this mine was what, in mining parlance was called wickedly vicious. An instance came to my attention, in this mine, which will illustrate. A driver, on going into a certain butt entry with his empty trip, had neglected to shut the trap door on the butt, and before he had time to gather his loaded trip and return, the firedamp had increased to the extent that the "diggers" were leaving their working places and coming out on to the main entry. I happened to be traveling along the main haulage road at the time and inquired why they were leaving their places. A few minutes afterward I found the door open and the driver coming back empty. Note the inconsistency of a man, who would in a discussion bewail the practical impossibility of removing the excess coal dust from the working faces, caused by the coal cutting chain machines, and advocate a sprinkling system, as a factor of safety, who at the same time was having his auxiliary haulageways, as well as his main haulage road, ballasted with bottom coal, to be pulverized to dangerous explosive dust.

I believe that if the mine manager's attention were called to matters of this kind, something would be done immediately to change conditions, particularly in mines generating firedamp. A visit to the different mines will show that a number are still in this class.

Ash Plant.—If this subject is given thought, it will be seen, that not only is an ash plant feasible, but it can be made a valuable adjunct to the mine operation.

The boiler plant should have an underground conduit to accommodate a special dump car. The ashes should be loaded into the dump car, from the ash pit by way of a chute, operated by a lever device. The dump car should be raised to the top of the ash bin by an auxiliary hoist. The bin should be so placed that free access can be had from the shaft head. Most mines have a percentage of rock that is more economically handled on the surface. These rock cars should be loaded with ashes and returned to the mine along with the daily supplies. In mines where no rock is handled, enough empty cars can be taken from the cage daily for ash purposes. In most cases this operation will require no additional labor cost, as the regular ash man, who would otherwise be wheeling ashes, can take care of dump car and hoist, while the regular man or men handling supplies can load the ashes in the mine cars.

In the mine, the ashes can be distributed much the same as supplies, on the off shift, if desired. Ashes are easily shoveled from a mine car, and it will be found that there is little additional cost in using ashes, when compared to the time spent by the track man and his helper in scraping up loose coal and slate for ballast.

In headings where grading is done, necessitating the ripping of roof, this material should be used for ballast, and the track at this point surfaced with ashes.

The extensive use of boiler ashes for track purposes, tends toward better mine tracks, which means increased output, toward a reduction in the number of wrecks, and will be a valuable asset as a factor of general safety.

Fig. 1. Glen White, West Virginia

Welfare Work at Glen White

Comfortable Houses—Good Water—Schools, Both Common and Mining, and Amusements Provided for Employes

*By George D. Evans**

FROM the date of its organization the E. E. White Coal Co. has been thoroughly in sympathy with every movement calculated to advance the interest of its employes. The first thing that attracts the eye of the visitor to one of the plants of the company is the neat and substantial class of homes provided for the employes. Fig. 1 is a general view of Glen White.

The houses are constructed with three, four, five, six, or eight rooms; are well built with stone foundations, weather boarded, plastered, neatly painted in colonial yellow and white, and are surrounded with ample ground for the industrious family that cares for a garden.

The people in very few mining villages are blessed with such an excellent supply of pure, fresh water as is enjoyed by the people of Glen White.

While sinking the shafts an underground stream of water bearing very little mineral impurities was struck in each shaft at a depth of about 140 feet. In each shaft a concrete ring was constructed and the water piped from the rings into a tank at the bottom between the shafts, from which it is pumped by a 12″ × 6″ × 12″ Goyne duplex steam pump into a pair of 25,000-gallon tanks on the hillside above the town. It is distributed from these through the entire village by a 6-inch main with 3-inch and 2-inch branches, giving an ample supply at a good pressure, not only for domestic use and fire protection, but also for the boilers.

Excellent school facilities are provided for both the white and colored people; and the short term prevalent in the West Virginia mountains has been lengthened by the operators, who have also added to the salaries paid, thus commanding the best instructors. Among the teaching force are Pennsylvania Normal School graduates and those who have taken advantage of training in the state universities. Pupils in the Glen White and Stotesbury schools, including children of foreign parentage, are in many instances, as far advanced as those of the same age in towns or cities.

It is the object of the company to build its official mining organization from its own ranks, and night schools are maintained by the company and those employes desiring

*Civil and Mining Engineer, Pottsville, Pa.

instruction are invited to attend free of cost. Fig. 4 shows the night school at Glen White in session.

Several of the company officials are graduates of the Mining Course of the International Correspondence Schools, of Scranton, Pa., and are well qualified to instruct their subordinates. The regular night-school work has been supplemented by first-class moving picture reels showing up-to-date mining methods; by home-made stereoptican views calling attention to the correct and the incorrect way of doing work; by simple, practical addresses delivered by representatives of the Morgantown University and by weekly talks by the company officials.

The company has just completed at the Stotesbury mine a recreation hall that will provide all necessary facilities for carrying this work to a practical end. Fig. 3 shows a side elevation of this building. At Glen White, plans are being made for a $10,000 structure which is being designed to cover all the educational wants of the company's employes. The management is particularly interested in the development of the lads who must enter the mines to assist in the family support, and very satisfactory results are being attained.

The reading of mining journals is encouraged by the management and every mine official is expected to subscribe for The Colliery Engineer and other publications, and in this way everything new in the mining world is brought to the attention of those in charge.

Fig. 2. Main Cross-Over, Glen White, Showing Thickness of Seam

This company is not alone in this New River smokeless coal field in the work of uplift and advancement. It is being carried on by all the leading companies in the field. The sale of daily papers is encouraged, and frequently the coal companies distribute hundreds, representing both political parties for the purpose of enlightening their employes.

Every mining town in the field has two or more churches so that the religious wants of both white and colored people are met and the management is always liberal in its support of church and pastor. Owing to the many nationalities and creeds represented it is no uncommon thing for several services to be held in a camp on Sunday morning and again in the evening. Like those in the anthracite field, the attendants at these services show by their dress and manner that they are prosperous and contented.

Nor is recreation or amusement neglected in these mining towns. There are halls for pool and billiards, bowling alleys and, at some towns, gymnasiums equal to those in larger towns. For outdoor recreation in summer, there are tennis and croquet courts, and every camp has a first-class baseball team. There exists among the baseball teams a great rivalry; and while the Sunday mornings and evenings are given to church services, the gatherings in the ball fields on summer Sunday afternoons are inspiring sights. In many of the camps the Y. M. C. A. takes an active part in the athletic as well as the religious life of the community.

Every mining camp in the field has a physician in attendance and it would be an error to suppose that these are men of ordinary ability, for the best medical schools in the country are represented. At Glen White and Stotesbury the doctors' offices are directly connected by telephones with all parts of the mines, and it is not unusual in case of an accident to see the doctor arrive at the drift mouth or top of shaft with full knowledge of the nature of the accident before those nearer know that there has been one. The chief surgeon of the company maintains an up-to-date hospital in Beckley, to which all serious cases are taken for treatment. At each mine the doctor has a room in the same building with the wash house where he can take injured men for immediate treatment and where he has all the facilities for the proper cleansing and dressing of a wound before sending the patient to his home or to the hospital in Beckley.

The stores at Glen White and Stotesbury are models in every particular. In charge of each is a man who has made a study of the wants of the people and sees that they are provided, and he is assisted by a polite and obliging force of clerks. The stock of goods is equal to that found anywhere and prices are reasonable.

The first shipment of coal was made by the E. E. White Coal Co., on July 1, 1909. On account of the dull times, the mines worked only about 4 days a week during the greater part of 1914, but the shipments for the year amounted to over 600,000 net tons.

The skeleton serves to protect the various organs enwrapped therein and as a safeguard against all things.

When the breathing is restored, apply artificial respiration taking into permission that there is assistants near at hand to take off the which the flesh and nerves are built upon.

The purpose a human skeleton serves is it shows plainly the bones by which a man that has studied it can render some aid in case of accident in some cases probably save life before medical aid arrived.

Fig. 3. Public Hall, Stotesbury, W. Va.

Fig. 4. Night Mining School, Glen White

"Howlers" by Mining Students

For the information of American readers, we state that a "Howler" is English slang for any remark or reply that inspires laughter. The "Howlers" following are a collection of answers to examination questions made by mining students in Great Britain and sent us by a British mining engineer.

The answers given in many instances show that the students evidently had *practical* knowledge of the subject on which they were questioned, but through lack of knowledge of proper words, and construction of sentences, made laughable answers.

First Aid to the Injured

Surround the patient with a current of fresh warm air, and a cup of strong coffee.

Of course, the rules that come under the head of treatment of fractures would be carried out and removed to a safe place on a stretcher.

Contused wounds are generally caused by some blunt instrument such as a blow with a fist and a black eye caused.

The blood works backward and forward from the heart, and the heart is like a pump and it goes in and out of a healthy man about 72 times a minute.

patient wet clothing and wrap him well in warm blankets to be rubbed upwards by the helpers.

The person suffering from sunstroke as several ailments attached to him after he is smitten down.

The heart is fitted up with valves to cause it to work properly and stop the blood from running back after having been discharged.

For a burn, cover the place with flour or treacle on a piece of limb.

Then allow the body to back with a jerk to make the patient gasp. Repeat these movements until the patient is roused or dead.

A comminuted fracture may be caused by a steam roller passing over a person or any other heavy weight.

When a bone is dislocated, it does not signify that it is broke.

Prior to the researches of Pasteur, the morality after hip amputation was 80 per cent.

The human skeleton serves as a covering for the intestines which are often delicate and cannot stand being knocked about.

The blood sprouts out at every beat of the heart.

The limb should be straightened out and well bandaged before being removed on a stretcher.

The skeleton of an human being or anything else is a framework on

Lay the patient with his or her nose facing against the wind which should be wiped and the mouth also. On no occasion treat the patient on the spot if it is freezing.

The boarders of the wound are irregular. Wounds may become infected from bits of animals.

Also treat a wound by applying linseed oil and limestone.

Make a steady, firm, downward pressure on the back (i. e., the lions).

To prevent germs from entering wounds, the treatment is to curl the patient up so has to close the wound by raising the head and shoulders and bending the knees. Apply a clean soft dressing to shut out the air and germs and transport the patient home with all speed.

If this is not a success, try artificial respiration until a doctor pronounces life to be a failure.

The heart is a hollow muscular organ of economical shape.

They must not leave the patient's tongue in his mouth if he is on his back.

The veins convey the impure blood laden with carbolic acid back to the heart.

A person who has taken a narcotic poison should be treated with strong coffee and mustard or grease served in warm water.

Symptoms of fracture: (1) a loss of a limb or part injured, (2) a joint is found where there ought not to be one, (3) pain and smelling at the seat of injury.

If a woman's skirt catches fire, she should be wrapped in a rug and soaked beforehand if possible and rolled on the floor.

The blood keeps on flowing until they become veins.

The human skeleton shows to any person the joint, bones, and inges in the body when dead, but whilst alive it serves to protect the more vital organs.

Should there be no dry boards, bricks, hay, or straw near at hand a person should stand on his own clothing or at least part of it providing it is dry.

Involuntary muscles occur in the walls of the vessels and internal vital processes of the body.

When a person is dressing a wound with a bandage he must be sure it is quite dissolved.

A triangular bandage is useful for making an extempore tourniquet.

In the case of a contused wound, the first symptom is the person does not know that he is injured until he notices a flow of blood.

Voluntary or striped muscles are those which are attached to the body in stripes.

If a burn is only reddened it may be covered with flour and then sent to the doctor.

The involuntary muscle is an internal organ, whereas the voluntary muscle is an external organ.

His head and shoulders must be covered with a succession of jugs of cold water.

As soon as possible obtain the services of a doctor. If this does not stop the bleeding, apply a tourniquet.

If the patient is suffering from shock, the clothing must be removed from above the waist and then laid on their back with the head slightly raised.

Give two or three slaps on the chest with the open hand. If the patient does not survive, use Schafer's method.

The patient's wet clothes should be removed and then wrapped in warm blankets.

The abdomen is chiefly composed of the organs of digestion—the liver, the spleen, the kidneys, and also a number of small intestines.

THE COAL MINES ACT

No horse must be used until it has been examined by a veneration surgeon.

A fireman in any mine in his district shall not be of such a size as would prevent him from carrying out his statutory duties.

All shafts sunk before 1887 although nearer than 15 yards are quite legible.

The driver of the engine shall attract attention by whistling and should be kept in good working order.

It is illegal to cross a passageway at the back or switchboards except below the floor or at a height or not less than 7 feet above the floor.

All breeches must be reported to the Manager before such breeches result in serious consequences.

No persons other than those repairing or taking animals shall be allowed to go down a shaft without it is in a cage.

These fences must be as a danger mark, so as to prevent any person from going inside, and they must be constructed in such a nature that it would be impossible for any person to enter it without knowing it was there.

The inspector should be notified immediately such accident occurs, such accident to be in writing.

Horses must not be under 4 years of age and all must be examined by a veterinary surgeon properly stabled when not working.

Nothing must be placed across the entrance and if necessary whitewashed.

A shot firer must not unlock a lamp to do nothing with whatever.

When horses are mentioned in the Coal Mines Act it means donkeys and mules.

MISCELLANEOUS

When 18 per cent. carbon dioxide is mixed or added in the air, it will prove fatal to life as there is not enough oxygen to supply the lungs and render death by suffocation.

An insulated receptacle is carried on the person's stomach, the capacity of which is little more than a gallon.

If we take the nitrogen out of the air, we will just have air and oxygen.

A sample bottle consists of two openings one at the top and the other close to the bottom.

Sulphuretted hydrogen has a disrespectful smell.

The value of a safety lamp depends upon the safety of the lamp.

The explosion is accompanied by a donation.

Carbon monoxide has a special gravity of .599.

Carboniferous fossils (plants) these are land animals that lived in the woods and swamps of the time such as spiders, insects, land snail, and fresh water mussel, etc. These come under the fresh water molluscs.

A Rapid Growth

An instance of the difference between efficient centralized management and that which is distributed and necessarily less efficient is coming to light in the case of the Sacandaga Coal Co. This company bought its first piece of property in March, 1913. It now has 600 acres of coal land and 2 miles of narrow-gauge railway connecting the properties in Mayfield and Carbondale, Pa. The annual output of the properties when acquired was a scant 30,000 tons. The work of the company is still in the development stage, but it has two breakers, Sacandaga No. 1, and Sacandaga No. 3, with a capacity of 250,000 tons a year. The output this year is expected to be 150,000 tons and by the end of 1916 the breakers are expected to be running at capacity. This instance tends to prove that the efficient administration of coal lands has as much to do with success as advantageous location and easy mining.

Mining Loads for Central Stations

Methods of Improving the Power Factor of a System by Careful Arrangement of the Work and Use of Suitable Motors

*By Wilfred Sykes and Graham Bright**

THE most desirable load for a central station is one which has both a high load factor and high power factor. Load factor is, generally, defined as the ratio of the average load of a machine, or system, to the rated capacity. Capacity should be based on some integrated time peak, that represents the power which the central station must provide, and hold in readiness, for use.

The load of a mine operation, taking power from a central station, consists, in general, of the following: Haulage, hoisting, ventilation, coal cutting, pumping, tipple or breaker power, machine shop and blacksmith shop, lights.

Haulage.—The load due to a haulage system, is, as a rule, very ragged. The variation, depending upon the number of locomotives operating and the grade conditions, has varied from 50 to 700 amperes in 5 minutes; but unless the power system has a rather small capacity, this variable load will not seriously affect the regulation for power loads, although it may give unsatisfactory regulation for lighting.

In practically all cases in this country, the power used for mine haulage is direct current, either 250 or 500 volts. With purchased power, the current is obtained either from synchronous converters or motor-generator sets. The motor-generator sets may be either induction or synchronous. When there are few locomotives in use the direct-current generator must be able to stand heavy overloads, for short periods, so that its actual capacity is often determined by its ability to carry heavy momentary overloads, rather than by continuous heating capacity. When this peak load is the determining factor, it is possible to supply a driving motor smaller than the generator, provided the motor has ample pull-out torque. The efficiency and first cost would be improved, when using such a motor, and also the power factor, if the motor is of the induction type. This scheme is particularly applicable where old generators are driven by steam engines and it is desirable to change to motor drive. In many cases, these old generators will stand little overload, due to poor commutation, and seldom receive overloads, owing to the inability of the engines to stand more than full load without becoming stalled. Instances have occurred when a 200-horsepower motor was ample to drive a 200-kilowatt generator. Where the capacity is not determined by the peak load, it should be determined by the r. m. s. rather than the average kilowatts, for both motor and generator, since the heating for such a variable load will be greater than that due to the average load.

The load factor of the haulage system can be improved in some cases by a careful study of the schedules on which the trips are brought to the surface.

The effect of the haulage load on the power factor of the system depends upon whether synchronous converters, induction motor-generator sets, or synchronous motor-generator sets are used.

With the induction motor-generator set the power factor will depend on the load, and will not average very high, due to the fact that the average mine load is low. The synchronous converter will have 100 per cent. power factor at full load, and can be made to give a slightly leading power factor at lighter loads. The synchronous motor-generator set has somewhat better characteristics than the synchronous converter, and is better adapted for mine service, due to the superior compounding characteristics of the generator. Heavy compounding is desirable for mine service, especially when the voltage is 250. The high power factor of the converter or synchronous motor-generator set will tend to compensate for the lower power factor of the fan, hoist, and tipple motors.

From a standpoint of cost, the desirability of the various types of apparatus for converting alternating-current power to direct power is in the following order:

1. Synchronous converter.
2. Induction motor-generator set.
3. Synchronous motor-generator set.

From a standpoint of best operating conditions, the desirability is as follows:

1. Induction motor-generator set.
2. Synchronous motor-generator set.
3. Synchronous converter.

From a standpoint of power factor correction, the desirability will be as follows:

1. Synchronous motor-generator set.
2. Synchronous converter.
3. Induction motor-generator set.

Hoisting.—In mines where hoisting is necessary, the load factor depends upon the nature of the hoist. Where the shaft is vertical, and high speed and frequent hoisting is required, the load curve covers a wide range in a few seconds of time. The momentary peaks are very high, while any integrated time peak of 1 minute, or more, will be fairly low.

*Abstract from paper read at the Pittsburg meeting of the American Institute of Electrical Engineers

This kind of load will often cause poor regulation on a power company's system, and is not, as a rule, a desirable load. However, if there is considerable haulage, fan, pump, and cutting load at the same time, the high peaks will be somewhat smoothed out.

Where the peaks are excessive, and cause bad regulation, some method of equalizing the load is used. The best known of these systems is the Ilgner, which employs a separately excited hoist motor, receiving power from a separately excited generator driven by an induction motor. By means of a flywheel, and slip regulator, the load on the power system will be practically constant. The selection of the hoisting equipment will depend upon the depth, output, and central station rate for power. For long slope hoists the variation in power is not so great as for vertical hoists, and the alternating-current wound-rotor motor has desirable characteristics. The power factor and efficiency are both low for the average hoisting conditions where alternating-current hoist motors are used, and the synchronous apparatus must be depended upon to improve the power factor.

Ventilation.—Fans for mine ventilation are in most cases of too low speed for direct connection to the motor.

When the fan operates at the same speed 24 hours per day, and is changed only at intervals of a few months, to take care of the mine development, a simple arrangement is to belt a constant-speed motor to the fan, and change pulleys when a change in speed is desired. The simplest type that can be used for this application is the alternating-current polyphase squirrel-cage motor. When this motor is to run at low load for long periods the power factor can be improved by a special winding. In some cases it is desired to operate a fan at a certain speed most of the time, and, occasionally, at a somewhat higher speed for emergency conditions. A simple method of accomplishing this is to supply double pulleys and so change the speed by belts. Since the motor is to be operated at a reduced capacity a large percentage of the time, it would be desirable to have a high power factor and high efficiency at light load. Fig. 1 illustrates what can be accomplished by supplying a special winding to a standard motor, to improve the power factor at light loads. The

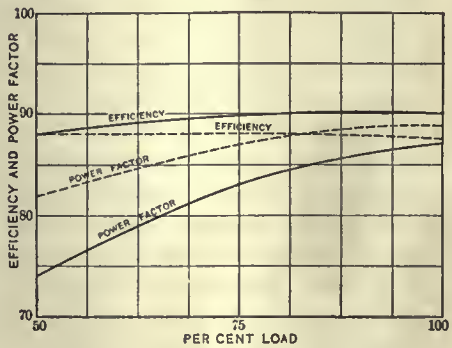


Fig. 1. Performance Curves of Squirrel-Cage Motor

Full line curves are for standard windings. Dotted line curves are for special windings designed for high power factor at light loads.

efficiency may suffer at full load, but this makes little difference, as the proportion of time that the motor operates at full load is small. The same effect can be accomplished by supplying reduced voltage taps so that the motor can be run at a lower voltage when lightly loaded.

When two definite speeds are required, these can be best obtained by the two-speed squirrel-cage motor, if alternating-current power is available. If direct-current power is to be adopted the commutating pole direct-current motor can be used to give high economy at a large range in speed, by field control. Where variable speed is required for an alternating-current motor, this is generally accomplished by using a wound rotor and putting resistance in the rotor circuit. The economy is of course low at any but full speed. The fan load, being very steady, will greatly improve the load factor and regulation. The power factor will not be high, since a fan motor is seldom run at full load.

Coal Cutting.—The power used for coal cutting is generally direct current, and is often taken directly from the trolley system. Much better voltage regulation can be obtained where separate feeders are run for the cutting machines. The load factor of a single cutting machine is rather low, as it operates but 10 to 15 per cent. of the time. Each operation lasts several minutes, so that the effect on regulation is not bad, and with several machines in operation, the load factor will be fairly high.

A practice which seems to be gaining favor is to do most of the cutting at night. This greatly improves the low load factor at night, and in many cases relieves the generators, which are overloaded during the day.

When air compressors must be used, they can, of course, be driven by motors. The induction motor is, as a rule, used for operating compressors, with a power factor ranging from 75 to 90 per cent. Synchronous motors are becoming popular for this service, but must be started with the load relieved by unloading valves, or by-passes.

Pumping.—When the pumps are some distance inside the mines, direct-current motors, direct-connected to centrifugal, or geared to triplex pumps, take power from the haulage, or coal cutting lines. For large pumps, alternating-current induction motors are used to advantage in most cases.

The load factor due to pumping will be very high, as a pump is usually run on constant load for hours at a time. In some mines the 24-hour load factor is very materially increased by using small pumps during the day to pump to a common reservoir or sump, and then using a large pump to raise the water out of the mine during the night. For these small pumps the self-starting, direct-current, commutating pole motor cuts down the pump attendance to a minimum.

Any scheme by which a day load can be shifted to the night turn will not only improve the load factor, but will cut down the capacity of the generating apparatus.

Tipple or Breaker.—Motors used on the tipple, or breaker, are gen-

erally of the induction type, squirrel-cage or wound rotor. Direct-current motors are frequently used where the operation has an isolated power plant. The load factor is fairly high, but the power factor will not average high, due to the fact that many of the machines are working underloaded at times. The load factor can only be improved by regularity of output, while the power factor can be best improved by a close study of the power requirements, to see that each motor is of the proper capacity for the work. In some cases, by the addition of a small flywheel the capacity of the motor can be reduced, and the power factor and efficiency increased. It is for such a load as a tipple, or breaker, that power factor correction is desired, by the use of synchronous apparatus.

Machine and Blacksmith Shop. The machine shop and blacksmith shop load is, generally, too small to have much influence on either load factor or power factor. Direct-current or squirrel-cage induction motors are used.

Lights.—The lighting load is a small percentage of the total, where the lighting is confined to the tipple and mine proper. This lighting is, generally, taken from the haulage system, to save wiring. With purchased power, all outside lighting should be alternating current, since the regulation on the haulage system is not suitable for economical lighting.

Table 1 shows a summary of the various load factors and power factors, and ways in which they can be improved.

TABLE 1. LOAD FACTORS AND POWER FACTORS AND SUGGESTIONS FOR IMPROVEMENT

Load	Load Factor Per Cent.	Method of Improvement	Power Factor Per Cent.	Method of Improvement
Haulage	15 to 30	Proper arrangement of schedule	70 to 100	Use of synchronous motor-generator sets or synchronous converters
Hoisting	10 to 30	Equalizing system	60 to 90	Equalizing system
Ventilation	100		70 to 90	Use special winding to give high power factor at light loads
Coal cutting	20 to 50	Do cutting at night to improve load factor of system	70 to 100	Use synchronous motor-generator sets or synchronous converters
Pumping	70 to 100	If possible change part of pumping to night turn	70 to 100	Use synchronous motor-generator sets or synchronous converters
Tipple or breaker	20 to 60	Keep output steady	50 to 70	Use motors of proper capacity—not too large
Machine shop / Blacksmith shop	40 to 70	Load too small to affect load factor seriously		Use of motors of proper capacity—not too large
Lights	60 to 90	Load too small to affect load factor seriously		If alternating current, use transformers of proper capacity—not too large

The Rosehall Signal Indicator

*By James Black**

Signaling in shafts, in common with almost every other mining operation, has not escaped the vigilance of legislators. General Regulation 95, Mine Act of Great Britain, states that, "In connection with every winding engine there shall be provided an appliance which shall automatically indicate in a visible manner to the winding engineman (in addition to the ordinary signal) the nature of the signal until the signal has been complied with."

At about 85 per cent. of the collieries in Great Britain, the shaft signals are transmitted by the ordinary wire-and-hammer arrangement, and for this reason the writer's remarks will be principally confined to this system.

With the object of complying with Regulation 95, a large number of signal indicators (which differ only in design) have been placed on the market. The writer has carefully investigated the construction and principle of action of a considerable number of these indicators, and, so far as he is aware, they are all of the accumulative type (with the exception of the one which he is about to describe)—that is, they indicate the sum of the signals given during any one operation. In the raising or lowering of men, or in the changing of decks, this may lead to confusion, and it is doubtless for this reason that the Home Office have refused to sanction the use of signal indicators which are accumulative in their action.

The Rosehall signal indicator is essentially different, both in construction and in action, from any other indicator which has come under the writer's notice; and he believes it to be at the present moment the only indicator that complies with the Home Office requirements. The outstanding features of this indicator are as follows:

1. Any number of levels or hanging-on places may be worked with only one instrument, as the level from which a signal is given is indicated simultaneously with the signal.
2. It indicates the proper signal, and shows the nature of the signal.
3. A signal may be repeated as often as is desired.
4. Its employment does not necessitate any alteration on the ordinary wire-and-hammer signaling arrangement commonly in use.
5. It is very compact, strong, durable, and reliable.

The instrument is so designed as to give visual indication to the winding engineman of the number and nature of the signals given. Provision is also made for giving visual indication to the winding engineman of the particular level or hang-

*Transactions Mining Institute of Scotland.

ing-on place from which the signal is given.

The apparatus is illustrated in Figs. 1, 2, and 3 and includes a number of slides *A*, Fig. 2, each of which presents on its surface a number denoting the order of the signal. The slides are so mounted in relation to an apertured dial, that as the selected slide is actuated the figure is brought opposite the corresponding aperture. The slides are guided to move vertically, and receive actuation from a system of levers *B*, Fig. 3, each of these slides operating with a pawl *C*, which serves to maintain the slide last to receive actuation in indicating relationship with the aperture. Each of these slides is formed with a cam surface, which in contacting with the pawl *C* releases the slide previously actuated, so that the latter is returned by gravity to its normal position. The actuating levers *B* are mounted to move collectively, and are moved separately into engagement with the slide to be actuated, such movement being derived from a system of tappets *D*, which come into contact with the lateral edges of the levers *B*. The tappets are disposed helically on the cylindrical surface of a barrel *E*, deriving step-by-step movement from a pawl and ratchet *F*. It will be understood that the position of the tappets will be determined by the number of signals given, and that the figure on the slide will correspond to such number. The barrel is so loaded that it tends to return to its initial position. In order to prevent immediate return of the barrel to its initial position, and thus permit of the continuation of its step-by-step movement when several signals are given successively, the ratchet is arranged to cooperate with a detent *G*, constituted by a loaded bell-crank lever *H*, one arm of which receives actuation from a loaded cylinder. This cylinder acts so as to retract the detent *G* from engagement with the ratchet, and thus permit the barrel to return to its initial position, so that on receipt of a subsequent signal the indication will recommence from zero.

From this description it will be understood that the figures on the indicator are not shown accumulatively—that is, for example, if 3 be signaled, and after a pause 1, the instrument would not indicate 4, but 1, as it is automatically arranged to extinguish the preceding signal. The indicator, which is entirely mechanical, and can be applied to existing bell arrangements without trouble, is thoroughly reliable in every respect.

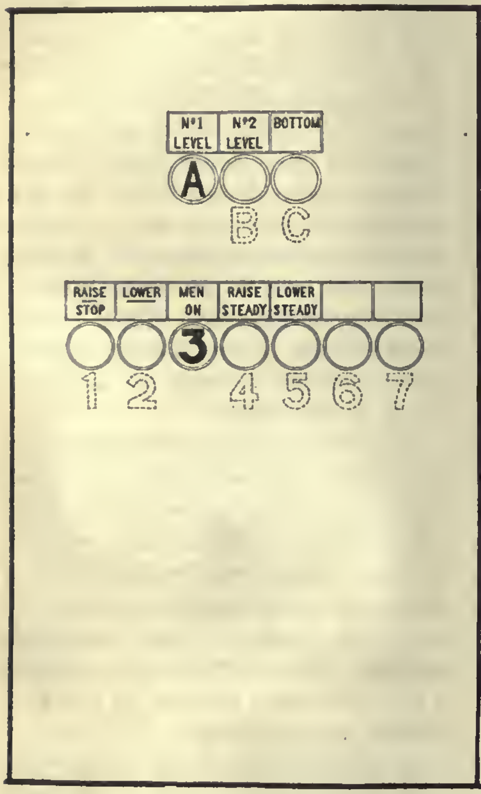


Fig. 1. Front of Signal Indicator

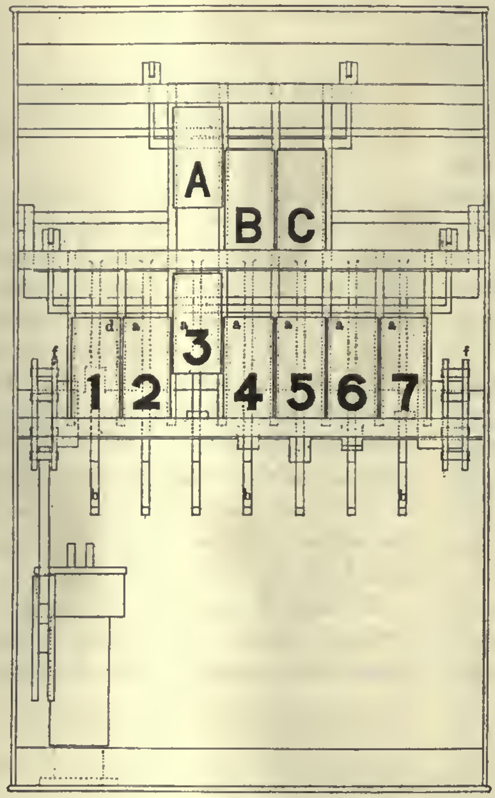


Fig. 2. Front With Apertured Dial Removed

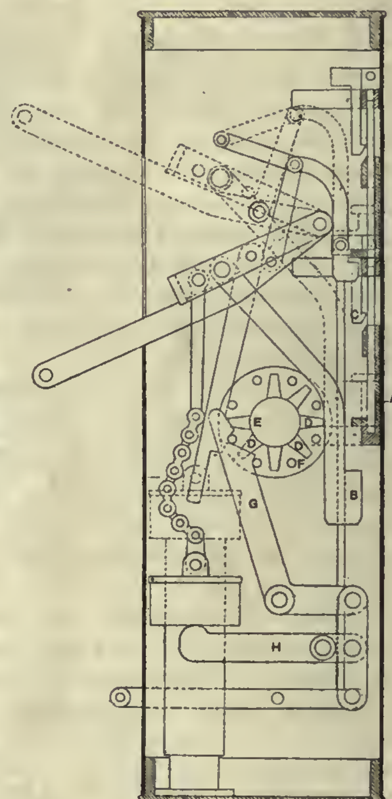


Fig. 3. End Elevation With End Plate Removed

Coal

Finely pulverized coal begins oxidation at a temperature between 120° and 130°, no tests exceeded 150°. Ignition temperature varies with the kind of coal and fineness of division. Finely divided bituminous coals ignite in oxygen at a temperature not far from 160° (buckwheat sizes ignite at about 120° and 130°; no tests exceeded coals ignite at about 200° and anthracite at about 300°, the latter finely divided.

The Preservation of Mine Timber

Benefits of Seasoning—Methods and Results of Applying Oily Preservatives by Painting, Spraying, and Dipping

By H. A. Appel*

THE underlying causes of decay in mine timber are well known and need no explanation. However, one great trouble to be overcome is the attack of locust, pine, hickory, ash, and oak insects. A study of the habits of these insects shows that they attack a living tree rather than the finished product, and are present in the timber when placed. Extensive tests were conducted by E. Henry in an abandoned mine near Nancy, France, and by R. S. Pearson, in India, in which particular attention was paid to insect attack. These tests demonstrated the value of heavy oily preservatives over the mineral salts. In this respect it should always be remembered that decay is due to outside agencies which attack the wood and not to a spontaneous decomposition.

Seasoning is one of the simplest methods of combating the attack of fungi. Sap wood contains a large amount of moisture together with sugar and albumen, which makes it particularly subject to infection if used in the unseasoned state. It is necessary to peel the bark in order to season properly, particularly removing the tough inner skin which clings so tenaciously to the wood of conifers. This is especially true for timber in its natural shape used for double timbering in the mine.

Season checking can be minimized by the use of S irons during the seasoning period, driving the irons into the ends of the timbers where checks appear. An S iron driven at right angles to such a check, holds the timber together and prevents the check from extending further.

*Of the Carbolineum Wood Preserving Co., New York. Abstract of paper before Engineers Society of Northeastern Pennsylvania.

Many benefits are to be gained from seasoning. Not only is the weight of the wood reduced (often as much as 40 per cent.), by the removal of the bark and the evaporation of moisture, and the shipping weight consequently minimized, but the strength is considerably increased. The strength of timber has been found to increase in direct proportion to the reduction of the moisture content so that a stick of perfectly dry timber is nearly twice as strong as when in the freshly cut or moist state. This is true whether the timber is used above or below ground.

Preservative method is applicable to all timber. It remains then to find the most economical and best treatment for specific requirements. There are four distinct methods of treatment. Brush, spray, open tank, and pressure.

Where the amount of timber to be treated is small or the timbers themselves are large and it would not be economical to install a tank, the brush method is used. It consists of painting the surface of the wood with a suitable antiseptic oily preservative, applied at a temperature of from 150° to 180° F. To those who have at heart the utmost results of the brush treatment, the heating of the oil is of paramount importance. One of the main reasons is, that the thermal death point of many fungi is 100° F.

For either initial or supplementary treatment, the spray method possesses many advantages; particularly is this true for supplementary treatment, to take care of season checking, where by frequent applications it is possible to put off the date of replacement indefinitely. The oil is applied in a heated state with an ordinary paint spray machine, provided with a long nozzle to reach overhead timbers. It enables the forcing of the preservative into checks, joints, and contact parts, and while considered wasteful by some, the use of a larger quantity of the preservative is offset by the reduced labor cost. Actual experience has demonstrated that two men can cover 2,000 square feet of surface per hour with a hand spraying machine.

For the requirement of mine timbers, the open-tank method of treatment is the most practical and economical. Tanks suitable for ordinary timbers can be built for $5. Treatment is given right on the job as the material is needed. A distinct advantage is being able to frame the timber before treatment. The open-tank method of treatment is the height of simplicity. Timbers are immersed in the heated oil for a length of time dependent upon the condition of wood, whether green or seasoned, kind of wood and its intended use. The low labor cost makes this method a most economical treatment. By the use of two tanks, one for hot and one for cold bath, a much heavier treatment can be given with consequent deeper penetration.

The pressure method known commonly as creosoting has many disadvantages. In the first place, the treatment is a complicated affair and can only be given at a plant that costs anywhere from $25,000 up. Such an equipment, of course, is out of the question for any one mine; therefore it means that the mine operator who cuts his timber on his own property at or near his mine has to

ship it to a creosoting plant to be treated, incurring freight both ways. Or, if he purchases lumber in the open market the same holds true, and there are extra handling and freight charges. It means that the timber cannot be framed before treatment, and a cut surface is left untreated and exposed at the very point where a heavy treatment is most needed, as decay starts at joints and contact points. Under conditions of practice, framing before treatment at pressure plants is impossible. If treated timber is purchased direct from the plant no inspection of the untreated timber can be made without additional expense.

Among the salt solutions now in use, the most common are zinc chloride and bichloride of mercury. Both are excellent antiseptics and fungicides. Under many conditions to which treated timber is exposed they must be eliminated from consideration. Timbers treated with them are immune from fungus attack so long as a sufficient amount of the salt is present, but in contact with water or damp earth the preservative leaches out of the timber, leaving it eventually unprotected.

Oily preservatives on the other hand being insoluble in water remain in the timber without being affected by contact with moisture, and it is from this class of preservatives that we get the best results.

Prominent among materials of this class are various distillates of coal tar and wood tar. Here again, however, the subject of permanence is of importance, since many of these products are quite volatile and in a short time evaporate from the timbers, not only leaving them without adequate protection, but filling the surrounding air with unpleasant vapors. This is particularly true of the wood tar creosotes.

Corrosive action demands some consideration. Mineral salts corrode bolts, nails, and spikes driven in treated woods; tar-oil preservatives act as lubricants. According to tests made by immersing steel in a tar oil and weighing the test piece at intervals of 1 week in order to determine by difference the loss by corrosion, it was found that the piece lost at a rate which would require 748 years in order to corrode 1 inch of steel. As a matter of fact the corrosion seems to fall off quite rapidly as though a non-corrosive coating were being formed. By plotting the values obtained, a curve was produced which would indicate that the corrosion would cease entirely in about 40 days.

A serious objection to many of the oil preservatives now in use is their extreme volatility. This is particularly true of ordinary coal tar creosote, such as is used in the pressure process of treatment, a large percentage of which when injected into timber is lost through evaporation within the first few months of exposure to atmospheric conditions. This must of course be taken into consideration as it tends to weaken the effect of the treatment and a proportionally greater initial charge must be given. In open-tank treatment, a large per cent. is also lost by volatilization in heating the oil. This is not true when using the higher boiling oils which have the more volatile constituents removed, so that the evaporation from the timber after treatment and loss by evaporation from open tank is reduced to a minimum.

A few concrete examples may serve to illustrate the result of the present method of specifying treatment. Suppose for instance that a certain set of specifications require absorption of 10 pounds of preservative per cubic foot in 7″×9″ ties. For every cubic foot of timber in a 7″×9″ tie there is very nearly 6.1 square feet, disregarding ends, or .61 square foot of surface per pound of preservative used. Experience has shown that this should give an average penetration of about 1 inch.

Again, disregarding the ends, on 4″×4″ lumber the surface over which the 10 pounds of preservative must be distributed per cubic foot of timber is 12 square feet or 1.2 square feet per pound of preservative. Since only one-half as much preservative is absorbed per square foot by 4 in. × 4 in. as is absorbed by 7 in. × 9 in., the depth of penetration in 4″×4″ material must be considerably less than in the 7 in. × 9 in. In other words, in order to get a penetration of 1 inch, you will require only 10 pounds per cubic foot in 7″×9″ ties, but 20 pounds per cubic foot in 4″×4″ lumber.

In the case of 12″×12″ lumber, with an absorption of 10 pounds per cubic foot, the preservative must be distributed at the rate of 1 pound for every 4 square feet.

It takes 128 shingles to make a cubic foot and they have approximately 1 square foot of surface each, or 128 square feet per cubic foot. A treatment of 10 pounds per cubic foot of such material would mean that 1 pound must cover 12.8 square feet, and the penetration based on the average for 7″×9″ ties would be only .048 inch. As a matter of fact more preservative than this can be applied by a simple brush treatment.

The saturated zone or protecting envelope therefore on the 4 in. ×4 in. will only be one-half as thick as that on the 7 in. × 9 in. Is it not reasonable to assume then that this protection for the 4 in. × 4 in. will prove adequate? Conversely on 12″×12″ lumber, it is demonstrated that 10 pounds of preservative per cubic foot would mean 1 pound for .4 square foot of surface, and the protective zone would be practically 1½ inches thick. If then a 1-inch antiseptic zone is sufficient for 7″×9″ timber, why should we add an additional 50 per cent. to this thickness when treating 12″×12″ timber?

In December, 1912, Mr. Albert E. Lister, mechanical engineer of the coal department of the D. & H. R. R., stated that "in treating timber for breakers, 8-inch and 10-inch and larger requires on an average about 5 gallons per thousand board feet, while the labor has amounted to about $3 per thousand board feet, a total of $7 per thousand board feet. This for two separate coats

on all timbers. With a tank for heating and dipping, the cost of labor would be considerably below the above amount, and the amount of oil absorbed would increase. The total cost, therefore, with dipping might be the same as given above for brush treatment."

Rich Hill Coal Co. for treating timbers in tipple gave cost as follows: 104,338 feet B. M. cost $236.30 labor to apply one brush coat or $2.623 per 1,000 feet and it takes 5¼ gallons to cover 1,000 board feet of timber or $364 per 1,000 for oil, making the total cost per 1,000 feet B. M. $5.90.

Susquehanna & New York R. R. costs for treating timbers for a coaling station were as follows: two coats, one hot, one cold; 2″ × 10″ to 12″ × 14″ timbers; $2.10 per 1,000 feet B. M. labor cost; total cost $10.15 per 1,000 feet B. M.

In all three cases the labor cost is about the same. The difference in the cost of preservative treatment, therefore, is due to the different surface area of the treated timber per thousand feet.

Mr. W. G. Morton, coal dealer, Albany, N. Y., in treating his trestle used the spray method. The trestle is 216 feet long; the track is supported by six 8″ × 16″ stringers on 19 concrete piers. There are 171 railroad ties and a floor of 2½-inch planking, 15 feet wide, or a total of 16,449 square feet of surface area. The cost was $.0069 per square foot or $4.134 per thousand B. M. This did not include labor, as work was done by yardmen when not otherwise employed.

It cost the Allentown Electric Light and Power Co. to treat 10-foot cross-arms by the open-tank method, 1 cent per cross-arm for labor and 7 cents per cross-arm for oil, a total of 8 cents treated. The Stone & Webster Engineering Corporation dip yellow pine ties, 6 in. × 8 in. × 8 ft. two minutes at a cost of 20 cents per tie, including labor, while on another job it cost Stone & Webster 31 cents to give open-tank treatment to 6″ × 8″ × 7′ ties. The Hutchinson Interurban Railway Co. treat white-oak ties at a cost of only 15 cents per tie.

The Peerless Motor Car Co., of Cleveland, Ohio, treated 150,000 feet of flooring, sills, and joists, in an open tank measuring 20 ft. × 3 ft. 4 in. × 3 ft. at a labor cost of $2 per thousand feet B. M.

Labor cost can be set very low. Unskilled labor can be used to apply wood preservatives with a brush, nor does it take the brains of a mechanical engineer to immerse a piece of timber in a tank of hot oil and keep it there for a specified time.

The preservation of gangway timbers, collars, props, etc., has been the subject of extended study by the United States Forest Service, and much literature has been published by them, with which you are no doubt familiar. It was my privilege recently to inspect 30 timber collars and legs in the Belleview mine. These timbers were placed in the mine in September, 1908, after having been given open-tank treatment with tar oil preservatives. All but two of these timbers were in first-class condition, one collar showing advanced stage of decay and one leg showing decay at the bottom. The most severe conditions existed where these timbers were in place, the bottom of a large percentage of them being in water and they were surrounded by untreated timbers which were badly decayed. The mine foreman told me that the untreated timbers had been replaced three times since these specimens were put in the mine, and these treated timbers looked good for many years' additional service.

A Field Day

The Colorado Fuel and Iron Co. will have a field day for its employes in Huerfano and Las Animas counties in August. The object is the creation of community interest and a friendly camp rivalry. There will be a first-aid contest, and various athletic contests, including one in coal shoveling, and a Boy Scout contest.

Discussion of Mr. Frank Haas' Paper on Mine Gas

*By E. B. Wilson**

Mr. Frank Haas' contention that gas from the deep-seated gas sands finds its way upwards into coal beds where it lodges, is interesting. When at Elkhorn, W. Va., in 1893, in the hope of finding water for coke ovens, I had a well drilled 500 feet deep, and, not finding water, continued it to 1,000 feet. At a depth of 800 feet a gas sand was cut, but the gas was under no pressure to mention, although 90 miles to the west producing gas sands were known to exist.

Up to that time no gas had been detected in any of the mines above water level, although it was certain that it would be when the coal went below water level, and this was proved at Bottom Creek the following year. No bore holes had been sunk in the strata on Elkhorn so that the mines below water level could not receive gas through them; and as the compact shales and sandstones were 1,000 feet deep at this place it is not probable that any gas came from below into them; therefore, I do not think Mr. Haas' theory will apply on Elkhorn Creek, which is evidently outside the gas belt. The natural gas found in the Elkhorn well had no odor.

In the anthracite fields of Pennsylvania the coal beds form canoe-shaped troughs with outcrops in the side hills. There is considerable gas in the coal beds and in the strata between coal beds and above the topmost bed below water level. This gas cannot be detected by any odor. No wells driven below the coal into the Mauch Chunk Red Shale have tapped gas, although one has gone to a depth of 1,500 feet looking for oil in Conyngham Valley.

It is remarked that neither natural gas nor oil has been found east of the Allegheny Mountains in the Blue Ridge and probably never will be, owing to the geological conditions that prevailed previously and subsequently to the upheaval of the Blue

*West Virginia Coal Mining Institute. Paper published in February issue The Colliery Engineer.

Ridge Mountains. It is unreasonable to expect, therefore, that gas would find its way from deep-seated gas sands into anthracite mines. However, the gas is there in such quantities as to make these mines as a whole the most gaseous in the world, so far as records show. It is also known that the gas comes from the floor, coal and roof, and is even in the soil above coal beds on the Susquehanna flats between Pittston and Nanticoke.

In the Wyoming Valley the lowest workable beds are the Red Ash and in them little gas is found. In the lower end of the valley, the Hillman bed about half way in the coal measures, or 600 feet above the Red Ash, is the one most heavily charged with gas, while at the upper end of the valley the Baltimore, or Pittston, bed is the most gaseous, pockets of gas being found which issue as blowers.

The Baltimore bed is 270 feet below the Hillman at the Woodward colliery, Kingston, and the Red Ash is about 212 feet below the Baltimore. At Pittston the Red Ash, or Dunmore, beds are about 650 feet below the surface. Near Nanticoke they are 1,800 feet below the surface, while at Dorranceton half way between the two they are at a depth of 1,130 feet.

In view of the fact that no natural gas has been detected below anthracite beds, and since there is no evidence that any ever did exist, Mr. Haas' theory, so far as gas from deep-seated strata is concerned, does not appear tenable in the anthracite fields.

That natural gas may work upwards from deep-seated strata is possible, but in that case the gas must be under sufficient pressure to overcome the water pressure which at 2,000 feet would be approximately 906 pounds per square inch. While fissures occur in limestone, and joints in sandstones, shales are impervious to water, and as a rule the joints and cracks in sandstone have been closed by sediment or cemented by solutions in the Subcarboniferous and Devonian formations. There is the possibility of water pressure coming from below and forcing natural gas upwards through bedding planes and cracks. As an illustration, the deep Belgium coal mines and the lower coal beds of the deep anthracite mines contain less gas than the upper beds. But here again a peculiar condition prevails, the lower beds were formed first and it is possible that the vegetation was in such shallow water that oxidation occurred; but it has been noticed in some pitching coal beds that gas decreased in quantity with depth. The general tendency of gas is to rise and if there had been fissures connecting the deep-seated gas sands with the coal beds, gas would naturally be found in coal beds, but gas was made from coal vegetation and in large quantities, and that it is generally found below water level is due to a natural balance, the water sealing it in and with the atmosphere holding it back.

That natural gas may work upwards from deep-seated strata in certain bituminous coal fields is almost proven by the comparatively small quantities of gas in the Red Ash beds at Nanticoke compared with the large quantities in the Hillman bed. Then, again, between Pittston and Wilkes-Barre, the Baltimore bed, which contains the most gas in this vicinity, is about 212 feet above the Red Ash, or Dunmore, beds. It is possible to find gas by digging shallow wells almost any place on the Susquehanna flats, and in two places bore holes were driven to the rocks above the very gassy coal beds in order to drain them of gas. In the vicinity of Ashley, gas has been burning from well casing pipes for 30 years, but whether these pipes are the original ones, the present company officials do not know.

This gas drainage has been going on without much diminution all these years, and yet there can be no feeders from deep-seated strata. In view of these facts it is evident, to the writer at least, that the gas found in anthracite mines is wholly derived from vegetation. It is known that marsh gas is forming in swamps and can be collected by running a stick down in the mud and using a bottle. According to J. D. Dana's calculations, it required, at least, 8 feet of vegetable matter to make a thickness of 1 foot of anthracite and 5 feet of similar material to make bituminous coal 1 foot thick. According to the same authority, 100 pounds of wood contains 49.66 pounds carbon and 6.21 pounds hydrogen; 100 pounds of anthracite contains 95 pounds of carbon and 2.5 pounds of hydrogen; and 100 pounds of bituminous coal contains 81.2 pounds of carbon and 5.5 pounds of hydrogen.

In order to make 100 pounds of anthracite, it required 397.28 pounds of woody material which contained 49.68 pounds hydrogen, but there is found in 100 pounds of anthracite 2.5 pounds hydrogen leaving 47.18 pounds hydrogen, which it is assumed goes into marsh gas. At normal temperature and pressure 1 cubic foot of H weighs .0053 pound, hence there is an equivalent of 8,940 cubic feet of hydrogen gas, and this converted to marsh gas would amount to 35,760 cubic feet that might have been formed when 100 pounds of anthracite was made. Anthracite, it is assumed for illustration, weighs 100 pounds per cubic foot, consequently in a short ton there is the possibility of 715,200 cubic feet marsh gas having been formed. A similar method of reasoning will show that bituminous coal formed less marsh gas.

Mr. Haas has particular reasons for questioning whether all the gas found in the coal beds in the vicinity of Fairmont is derived from the original vegetation. At one mine in his jurisdiction about 1,000,000 cubic feet of gas per day are liberated, while an adjacent mine working in the same seam has very little gas. From a theoretical standpoint and from some of the actual conditions which prevail in the anthracite fields, it is not improbable but that the gas could have been derived from the coal; however, because of the location of the mine in question we are inclined to believe in his case

that gas wells are the cause. Another question which Mr. Haas' paper has brought out, is that of mine gas containing no ethane (C_2H_6). On looking at the authorities,* it was found that gas from a number of natural gas wells contained no ethane, the maximum from one well only being 16.75 per cent. and very few were above 5 per cent. In the same list there is a mine gas from Dorranceton, near Wilkes-Barre, Pa., that contains .39 per cent. olifiant gas C_2H_4 (ethene). This analysis of mine gas was made prior to 1908, and as none has been found since, on account of the difficulty of detection even by modern methods this analysis might be rejected without injury to mining. Very little ethene (C_2H_4) accompanies natural gas, and only in one case was over 1 per cent. discovered.*

The subject presents so many different angles in the gas fields, including records where the gas has found its way laterally through strata into drift mines from bore holes, one is unable to state with any degree of satisfaction that gas does not come from the deep-seated strata into coal beds whether or not bore holes have been drilled.

By-Product Coke in New York

The Merchants' Association of New York City present four essential factors that tend to show why New York should be a greater steel center than Pittsburg. They are: (1) The cost of securing the iron ore. (2) The accessibility of limestone deposits. (3) The cost of reaching the markets. (4) The cost of fuel supply.

In discussing the latter, the Association advocates by-product coke. The fundamental factors in the success of by-product coke production are the availability of an adequate coal supply at a low cost and a large market for the sale of the by-products. New York is the most important coal depot on the Atlantic seaboard. New York also presents the largest market in the United States for the sale of the by-products.

A suitable coking coal can be secured at the mines for $1.15 per ton. The average rail rate to New York is $1.85 per ton, making the total cost of the coal at New York $3 per ton. Based on this price the following estimates made by the consulting staff of two large by-product coke companies present a close estimate of the cost of coke on New York harbor. These analyses were made for two different qualities of coal:

Table 1. Cost of By-Product Coke in New York

2,000 pounds of coal at $3 per long ton	$2.66	
Total coking expense	.73	
Total debits		$3.39
Credits from the sale of the by-products:		
6,000 cubic feet of gas at 12c. per M	$ .72	
25 pounds of ammonia sulpbate at 2½c.	.62	
9 gallons of coal tar at 2c.	.18	
Total credits		$1.52
Total net cost 1,200 pounds of coke		1.87
Total net cost 2,000 pounds of coke		3.10
Interest and depreciation		.40
Total cost of coke per ton		3.50
Total cost of coke per ton iron (1.10 tons of coke used per ton of pig iron)		3.85

Table 2. Cost of By-Product Coke in New York

Debits		
Coal	$3.00	
Conversion costs	.75	
Amortization	.15	
Interest on investment	.24	
		$4.14
Credits		
5,500 feet of gas at 15c. per M		$ .83
22 pounds of ammonia sulphate at 2½c.	.55	
6 gallons of coal tar at 2¼c.	.14	
Total credits		$1.52
Cost of coke per ton of coal carbonized (assuming a yield of coke from coal of 75 per cent.)		2.62
Net cost of coke per ton		3.49
Total cost of coke per ton of pig iron (1.10 tons of coke used per ton of pig iron)		3.83

Based on these estimates, a comparison with the cost of coke per ton of pig iron in other producing districts is shown in the following table:

Wheeling	$3.77
Lake Erie	4.51
Pittsburg	2.97
New York	3.85

(By-product coke in New York, Connellsville coke in other districts.)

Pittsburg has, therefore, an advantage of $.88 in securing its coke supply.

Assuming that a profitable market for the by-products from coke production could be secured in Pittsburg, the Pittsburg producer would then have a more pronounced advantage over New York. A suitable coking coal can be placed in Pittsburg at a cost of $1.70. On this basis the cost of by-product coke in Pittsburg would be $1.94 per ton of pig iron. At this price the Pittsburg producer would have an advantage of $1.91 over the New York producer. To offset this disadvantage the New York producer secures a saving of $3.11 per ton of pig iron in transportation costs through the use of Adirondack ores, $1.89 per ton of pig iron through the use of Cuban ores, and $2.42 through the use of Newfoundland ores. Moreover, the transportation cost of placing Pittsburg pig iron in the New York market is $2.45.

Permanently Hard Water

The phrase permanent hardness is applied to water containing substances that are not precipitated by boiling. Among these are calcium, and magnesium sulphates, calcium chloride and magnesium bicarbonate. The usual practice followed to precipitate these impurities before they enter boilers is to use carbonate of soda Na_2CO_3 which unites with the calcium sulphate and forms sodium sulphate and calcium carbonate. The latter material is insoluble but the former is very soluble. It is considered harmless unless highly concentrated, and concentration is prevented by blowing out the boiler. In many instances this treatment is not sufficient and in any case the barium carbonate is better, as two practically insoluble compounds are precipitated, thus:

$$BaCO_3 + CaSO_4 = BaSO_4 + CaCO_3$$

By heating the water, precipitation may be materially hastened and filtration as practiced in the Sarge-Cochrane system will still further aid in purifying the water quickly. By collecting the precipitate, mixing it with coal and then calcining, barium carbonate, calcium sulphate, and calcium oxide are formed. Some barium sulphate will remain unregenerated.

*Vol. IX, University Geological Survey of Kansas, by Haworth, page 271.

United States Foreign Coal Trade

The Production, the Consumption, and Export Facilities of the Different Countries of the World

By Edward W. Parker

AT THE present time the world is producing coal at the rate of about 1,500,000,000 short tons a year. The interruption to mining and to trade generally by the war in Europe may cause the output for the current year to fall somewhat below that figure, but as in 1913 it amounted to approximately 1,450,000,000 tons we can safely assume that the world has an annual productive capacity of a billion and a half tons. Of this great tonnage more than 98 per cent. is produced on the continents of North America, Europe, and Asia, and less than 2 per cent., or approximately 26,000,000 tons, is from the countries of South America, Africa, and Oceania, which lie south of the equator. The reason for the much more important standing of the northern hemisphere as a coal producer may be readily appreciated when one looks at the estimates of the world's coal supplies as presented before the International Geological Congress at Ottawa, Canada, last year. Nearly three-fourths of the land area of the globe lies north of the equator, but the proportion of the coal reserves in that half of the world exceeds those of the southern hemisphere in almost the same degree as does the production. The estimates presented at the Congress show that the total coal reserves of the world amount to about 7,400,000,000,000 metric tons (8,157,000,000,000 short tons), of which about 7,140,000,000,000 tons (7,870,000,000,000 short tons) or nearly 97 per cent., are in North America, Europe, and Asia, and about 260,000,000,000 metric tons (290,000,000,000 short tons), or a little over 3 per cent., are in South America, Africa, and Oceania. The northern hemisphere has in reserve about 213,000 short tons of coal per square mile of land territory; the southern hemisphere has less than 21,000 tons. It needs no complex rule of mathematics to deduce from these figures that the one-fourth of the land south of the equator must draw upon the three-fourths at the north for a large part of its fuel supply.

Before going further I should probably state that practically all of the coal south of the equator is in South Africa and Oceania; that South America, so far as we know, is almost destitute of high-grade coal, the known reserves amounting to only 2,300,000,000 short tons, and the total probable reserves to only a little over 32,000,000,000 tons, and that the two-third of Africa which lies north of the equator is also coalless. Europe's share of the coal reserves is placed at 784,000,000,000 metric tons (864,000,000,000 short tons), something over 10 per cent. of the world's supply, and Asia's at 1,290,000,000,000 tons (1,411,000,000,000 short tons), or about 17.5 per cent. of the total. North America is credited with more than two-thirds of the total reserves, with an aggregate supply of over 5,000,000,000,000 metric tons (5,500,000,000,000 short tons), of which the United States, including Alaska, has nearly 4,200,000,000,000 tons, or more than one-half of the total world's supply and nearly twice as much as that of Europe and Asia, combined. Of the European supply of 864,000,000,000 short tons, Great Britain has nearly 25 per cent., or 189,500,000,000 metric tons (208,900,000,000 short tons), and Germany 423,000,000,000 metric tons (466,000,000,000 short tons), or about 2¼ times as much as Great Britain.

Considering the quantity of stock on hand, Great Britain has been by far the largest producer of coal, and until it was exceeded by the United States, in 1899, was actually the leading country in the quantity of coal mined and marketed. Great Britain is still the largest exporter of mineral fuel, her total exports in 1912 amounting to 64,444,395 long tons (72,177,722 short tons). Germany has not been, and probably will not be, an appreciable factor in the world's barter of coal, except as to her trade with her own dependencies and the supplying of her own naval vessels and merchant marine. Germany's total exports of coal in 1913 were 34,573,514 metric tons, or 38,110,384 short tons, more than one-third of which, or 12,152,000 metric tons (13,395,150 short tons), was sent to Austria, and Holland took 7,217,606 metric tons (7,955,967 short tons), the remainder being distributed among the other countries of Continental Europe.

Germany has rather pursued the not unwise conservative policy of using her fuel at home and exporting to other countries the manufactured products which bear the familiar legend, "Made in Germany."

Great Britain's profligacy with her coal supply has had much to do with making her the greatest maritime country of the world and the greatest carrier of ocean-borne freight, but she is now beginning to feel the pinch of poverty in connection with her coal supplies, and it would not be surprising if, when the present war is over, Great Britain should limit her export trade to the needs of her naval vessels and

bunker trade. To what other country then than the United States are those countries, in themselves partly or entirly barren of coal, to look for their fuel supplies? It does not appear that the United States has any reason to fear a shortage of fuel for many years to come, some centuries, in fact; but there are some economic questions to be considered. England has an advantage for export in coal from the proximity of her coal fields to the seaboard, in some cases the coal being loaded directly from the mines into vessels. All of the coals in the United States which are available for export are some distances inland, and rail or water hauls, with transshipment to vessels at the seaboard, are necessary. This condition is somewhat counterbalanced by the fact that although wages among the British miners are lower than in this country the total cost of mining in the United States is lower, owing to more favorable natural conditions and to the large extent to which mining machines have replaced the more expensive hand labor. Probably our prices at the seaboard for Clearfield, Cumberland, New River, Pocahontas, or Alabama coals do not exceed those of English coals of comparative quality.

Great Britain's exports of coal in 1912, which, as already stated, amounted to 64,444,395 long tons (72,177,722 short tons), were distributed, by continents, as follows:

	Long Tons
Europe	52,156,670
Africa	4,825,654
Asia	717,537
Oceania	4,273
South America	6,477,238
North America	262,977
Central America	47

How much of this was to Great Britain's own coaling stations it is not possible to say, but it is interesting to note that 80 per cent. of her exports of coal went to Continental Europe. Of this, France took 10,190,948 long tons (11,413,862 short tons); Italy, 9,180,208 tons (10,281,833 short tons); Germany, 8,394,864 long tons (9,402,248 short tons), and Russia, 4,046,644 tons (4,532,241 short tons). The exports of coal to South America were 6,477,238 long tons (7,254,507 short tons); to Central America, 47 tons (53 short tons), and to Africa 4,825,654 tons (5,404,732 short tons).

The exports of bituminous coal from the United States in the fiscal year ended June 30, 1913, amounted to 16,083,101 long tons, distributed by continents as follows:

Other countries in North America	14,877,291
South America	441,368
Africa	235,376
Europe	475,713
Oceania	53,353

It will be noted that of the total exports of 16,083,101 long tons, only 1,200,000 tons were sent to other continents than North America.

Our export trade in bituminous coal, while still small when compared with that of Great Britain, has shown a decided growth in the last few years, having increased from less than 10,000,000 long tons in 1909, to nearly 18,000,000 tons in 1913, a gain of 86 per cent. in 5 years. Naturally during the continuance of the war there will be an increasing demand for American coal, probably as much of a demand as we can find vessels in which to send it; for at no time in our history has the paucity of American vessels been so forcibly thrust upon us as at the present juncture. I recently observed a list of 24 vessels that had cleared with coal from Baltimore and Hampton Roads. Ten of them were British, 4 were Norwegian, 5 were Italian. The others were Greek and Danish—not an American vessels in the lot!

It looks somewhat strange, and is a source of mortification, to note that with all the coal and other commodities the United States has for export, nearly all of our shipments to foreign countries are made in foreign bottoms. A recent published statement of the merchant marines of the different countries shows the United States in third place, with a total net tonnage of steam and sailing vessels of 2,700,000, while Great Britain has over 11,700,000 tons, and Germany over 3,200,000 tons.

If Great Britain should cease to export coal it is probable that a good portion of the trade that goes to southern Europe might come to the United States. In 1913 the exports of British coal to Portugal, Spain, Italy, Austria-Hungary, Greece, Roumania, and Turkey aggregated 15,760,541 long tons. It is doubtful if the United States would export any coal to Germany, Russia, Belgium, or France, though in the southern part of France we might find some markets. Norway, Sweden, and Denmark, which together have been taking some 9,000,000 tons, may have to look to the United States for some of their fuel supply. Altogether it seems possible for the United States to be able to place somewhere between 15,000,000 and 30,000,000 tons in Continental Europe. This, of course, upon the peradventure of British coal being withdrawn from the markets. South America requires at the present time about 6,500,000 tons, and there is no reason to expect a decrease in these requirements, unless perchance there should be brought in some oil fields in that continent which would supply liquid fuel to the displacement of coal, as has been done in Mexico and in our own Pacific States. What coal there is in South America is principally in Cólombia, Peru, and Chile, the first possessing about 85 per cent. of the total. Small areas also exist in Venezuela and Argentina. The total reserves of the continent are estimated at 32,100,000,000 tons, and the annual production is between 1,500,000 and 2,000,000 tons (not as much as is produced in Arkansas, which ranks twenty-second among our coal producing states). Nearly three-fourths of the total production of South America is in Chile, on the west coast. The principal exports of British coal are to Argentina, Brazil, and Uruguay.

Africa requires something over 4,800,000 tons, in addition to what is produced in that continent. The coal fields are chiefly in the Transvaal and Natal, and produce enough only for their own requirements.

In discussing the possibilities of developing these foreign markets one important factor must be con-

sidered, and that is that the high-grade coals only will be available. It must not be coal that will fire spontaneously, and it must be mined and shipped with care so as to avoid an unduly large proportion of fines. Complaint is made of the large quantity of small coal contained in the American shipments. If we want to get and to hold the trade, we must supply the quality of coal that the buyers want, not that which we want to get rid of; and we must be prepared to furnish it when it is wanted, not make it the opportunity of simply unloading a surplus. That surplus represents, by the way, what is a sort of ever-present evil, potential if not actual, in the bituminous coal mining industry. The productive capacity of the bituminous coal mines of the United States is nearly 30 per cent. in excess of the four and three-quarter million tons produced in 1913. In that year the average number of working days made at the bituminous coal mines of the United States was 232, an unusually large average yet too short a working year to satisfy the ambitious mine worker, and the average production per day was 2,060,000 tons. If the mines had worked a full 300 days, and the average production per man were maintained, the output would have amounted to 618,000,000, or about 140,000,000 tons more than the quantity actually mined. In spite of this bad economic condition new mines are constantly being opened, and as they can for a few years produce coal at less cost than the older mines with deeper workings and longer hauls, any decided improvement in the near future is not apparent. A movement toward correcting the evil is observable in the tendency to operation in large units by which, as is well known, mining costs are reduced. This tendency is exhibited in the United States Geological Survey's report on the production of coal in 1913, which shows that in that year 50.5 per cent. of the production of bituminous coal was from mines producing 200,000 tons, or over, whereas in 1909 the percentage from that class of mines was 42.5. The percentage of production from small mines—those producing less than 10,000 tons, decreased from 35.6 in 1909 to 29.9 in 1913. Even in the already highly concentrated anthracite operations the percentage of production from the largest class of mines increased in the same time from 85.6 to 89.5.

I cannot say that I am altogether in sympathy with the idea of sending our best coal to supply the needs of foreign consumers, but my personal predilection has nothing to do with the case. If the producers of American coal want that foreign trade, let them go to it, and if this outlet shall help to take care of our excessive capacity and result in some better returns to the coal operators for the energy and capital they have put into the business, few there are who are familiar with the coal mining business that will object. Doubtless by the time our supplies of high-grade coals are growing low, the world's dependence upon coal will be less than it is at the present day.

Institute Meetings

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George Street, London, S. W., on Thursday and Friday, May 13 and 14, 1915. May 13 has been provisionally fixed for the annual dinner, and a further announcement will be made if it is found possible for the dinner to take place.

The Rocky Mountain Coal Mining Institute will hold its next meeting at Trinidad, Colo., June 8, 9, and 10. The following committees have charge of the meeting:

Program and Entertainment: W. F. Murray, J. P. Thomas, M. O. Danford.

Transportation Committees: Wyoming, Frank Manley and P. J. Quealy; Utah, W. C. Ferguson and A. C. Watts; New Mexico, G. A. Kaseman and T. H. Obrien; Colorado, W. J. Murray and C. W. Babcock.

Advantages of the Western Kentucky Field

*By F. V. Ruckman**

This is not an effort to go into the detailed advantages enjoyed by different mines, but a summary of the advantages enjoyed in general by the coal mines of western Kentucky.

The coal business has its full share of disadvantages, each field usually having its different problems to meet and, no doubt, operators have felt at times that these were great. Western Kentucky operators are fortunate in possessing advantages which, when summed up, present a very attractive total.

Nature did her full share in forming the coal measures with a fairly uniform dip, giving a practically level floor well adapted to whatever haulage system each mine demands. That full advantage has been taken of this is evidenced by the different systems in successful operation, viz., mules, electric motors, gasoline motors, rope haulage, and steam locomotives which are in general use in the field. This and numerous other smaller features can be appreciated when contrasted with the conditions existing in irregular or rolling seams. The two coal beds most worked at present, No. 9 and No. 11, are fairly regular in height and uniform in quality throughout the entire field. The average thickness for No. 9 is 5 feet, although it occasionally thickens to 5 feet 6 inches and seldom is thinner than 4 feet 7 inches. No. 11 bed is slightly more irregular than No. 9, but where worked shows a thickness of 6 feet or over. The No. 12 bed is being developed in Webster, Hopkins, McLean, and Muhlenburg counties. This coal is of good quality, the bed being from 4 feet to 6 feet in thickness. There is also development work being done in the No. 5 and No. 6 beds. The existence of faults and pinches is very rare and it is seldom that they are encountered in even their mildest form.

The roof is strong and firm and

*Gen. Mgr. Highland Mining Co., Providence, Ky.

withstands the great shocks where shooting off the solid is practiced. When given the watchfulness and ordinary care in timbering that the best of roofs deserve, little trouble arises from this source. In the No. 11 bed where thick slate is at times encountered, its section is well understood and it is handled with little difficulty. The limestone above the slate is almost a perfect roof, in fact there are rooms from 20 feet to 25 feet wide and 300 feet long that have been standing from 8 to 10 years without a prop, and the roof remains in perfect condition, and this is in a mine where all the coal was shot from the solid.

Kentucky has one of the best records for the small number of fatalities in mining of any of the states, and it is to be hoped that mine owners will continue doing their share in keeping this record. The government report for 1913 gives the fatalities in Kentucky for that year as 48. Of this number, 24 were due to falls of roof; 5 men were suffocated in an abandoned mine; 4 were killed by electricity, and 15 happened from miscellaneous causes. The death rate per thousand being 1.8 and the quantity of coal mined for the year to each death being 408,679 tons. This was commented on as being one of the finest records of the year.

Water, while always a problem, is a simple one in western Kentucky; it is never encountered in large quantities, and owing to the regularity of the bottom rock there is little trouble with drainage, wet rooms and entries being uncommon. The water supply for power plants, while not as abundant as could be wished, is sufficient except in extremely dry years. Rain water stored in ponds and lakes is practically pure for boiler purposes, and by the use of this water many serious troubles are avoided, as water from most other sources contains minerals in solution very destructive to boilers.

Owing to the comparatively shallow depths at which the coal is mined the serious conditions to be met with in deep mining are unknown. Neither is it found necessary to leave large chain and barrier pillars with the resultant danger and expense in drawing them. By the use of comparatively small pillars which are drawn as conditions permit and without elaborate preparations, about 87 per cent. of the coal is recovered, which quantity compares favorably with the best results obtained in other fields.

The western Kentucky coal field is in a good timber, farming, and stock raising country, which furnishes a good supply of oak for ties and rails and various other kinds of wood suitable for props. It is rarely that operators have difficulty in procuring good mules, and feed is readily obtainable.

The climate of western Kentucky is favorable for mining, for though as a rule the winters are cold, there are seldom blockades by snow storms, a common occurrence in some fields when the demand for coal is greatest.

In coal preparation the field has an enviable record for clean well-sized grades. The few impurities in the coal are removed by careful picking at the tipple without the use of expensive machinery.

This field has steadily adhered to a few sizes, adapted for general purposes and thus escaped the conditions existing in nearby fields where all the different grades up to 8-inch lump are being made to fill a demand created by the operators themselves. This kind of refinement has resulted in an enormous increase in screenings, too much of which must be marketed at a loss. It is understood that there is now a movement on foot in these fields for a return to the use of the 1¼-inch bar screen as the standard for lump coal.

In transportation facilities this field is particularly favored. The two great railway systems entering this field supply modern, well-maintained euqipment, which insures a car supply and rapid movement of shipments.

The brightest days for western Kentucky coal operators are not far ahead, the great industrial development of the South is progressing more rapidly each year, with the resultant increase in demand for coal. The operators are steadily feeling this demand, for in 1913 the western Kentucky field produced an increase of 644,312 tons over the production for 1912.

Sprinkler Systems for Wooden Breakers

Sprinkler systems that can be turned on by hand from outside the buildings are being installed in fourteen of the wooden anthracite breakers of the Lehigh Valley Coal Co., and installations in two more are planned. Four of the breakers have already been equipped, and ten are under way. At recent tests of these new systems before a Committee of the Underwriters' Association of the State of Pennsylvania, the committee agreed to recommend a substantial reduction in the high rate of insurance now in force on these wooden breakers for breakers thus equipped.

It is almost impossible to enter a breaker which has caught fire. The conflagration is quick and hot, fed by the coal and the numerous drafts throughout the immense open structure. The new sprinkler systems consist of pipes 10 or 15 feet apart with nozzles pointing upward at equal intervals which dash the water against concave circles of metal, causing it to spread out in umbrella shape as it falls to the floor. The nozzles are so placed that the falls of water will overlap and cover the entire breaker area.

This system will throw 800 to 3,000 gallons of water a minute, a quantity equal to from one to four fire-hose throwing 750 gallons a minute. It will extinguish any small fire and prevent one that has gained headway from spreading further. Wooden breakers are extremely inflammable and a number of them have been burned to the ground. This involves not only a

replacement cost of from $150,000 to $200,000, but loss from the fact that no coal can be mined for many months from the shafts that feed the breaker, as the means of preparing the coal for market have been destroyed. These new systems supplement but do not replace any of the regular fire fighting apparatus installed in every breaker, such as hose, standpipes, fire-pails, sand pails, water barrels, and hand grenades.—*P. & B.*

Government Ownership and the Miner

By Ernest L. Bailey, E. M.

"New York, Jan. 30.—Amos Pinchot, a witness today before the federal commission on industrial relations, declared that government ownership of mines and other natural resources was the only doctrine in which there is any hope for the alleviation of industrial evils. These resources were at present controlled by monopolies, he said, and this control resulted in the restriction of labor and unemployment." —News despatch.

The conditions that now obtain in Colorado and Ohio, linked with the recent bitterness in West Virginia, are fast bringing the general public to speculate upon the feasibility of, if not actually to tolerate, the idea of government-owned coal mines.

The active advocates of the measure are as yet few in number, but their unsurpassed facilities for attracting the public eye through the medium of the press, due to the sensational nature of their claims and policies, is enabling them rapidly to make inroads into public opinion —the supreme court of all legislation.

It is characteristic of the average American to treat with indifference legislation which does not affect his own individual interests.

Again, the constant reiteration of the desirability of a certain legislative measure has a marked psychological effect upon the American political pulse. It is therefore conceivable that the national congress could, at no very distant period, take the identical action advocated by Mr. Pinchot without encountering any withering storm of protest or even general disapproval from the rank and file of the voters of the United States.

Without inquiring into the justice of the contentions of either capital or labor in the present disputes, let us endeavor to examine impartially, and to analyze carefully, the reasons which have been advanced in favor of government ownership of coal mines, and determine as far as possible how such ownership would really affect the one who is chiefly interested—the actual miner and his coworkers.

Those defending the proposition tell us that the present system of mining, which is carried on by individual competing capitalists, served by competitive wage labor, must be superseded by national ownership which will gauge production to market requirements, impartially apportion the required tonnage to the different fields in proportion to quality of product and capacity of production, and equitably distribute the revenue derived therefrom, above interest on bonds, sinking funds, supplies, and other necessary expenses, to the various workmen.

Coal mining, they allege, is carried on by the united efforts of thousands of men, and is no longer an individual function but a social and collective one. They assert that the great coal mining concerns are no longer conducted by the owners, as such, but by a paid staff of officials under a manager, which organization could, without shock, be transferred to the direct supervision of state or nation.

And from such transfer they could reasonably expect the following advantages to accrue: The complete elimination of strikes, a uniform wage scale, uniform tenement conditions at new plants and existing plants made as nearly uniform as practicable, and a uniform percentage of profit in the government stores.

As it is the purpose of this paper to deal only with the case of labor, the legal and ethical arguments in opposition to government ownership will not here be given. There is, however, an economic argument against it which cannot well be overlooked. Experts who have studied the matter assure us that there is a point in the concentration of production which limits the highest efficiency and that beyond this point efficiency is lowered to a degree corresponding to the overproduction.

In every part of the world where efficiency has been made a study it is universally recognized that competition is the most potent factor working to promote it. Greater efficiency is stimulated among workmen by the awarding of prizes for which they individually compete. One firm must produce an article superior to that of the rival concern for the same money or the same article for less money if it hopes to expand its business, and unless there are many natural advantages to be derived from its location this can be done only by a greater efficiency in production.

Now let us consider the conditions upon which the government could take over the mines. First, the present owners must be paid a fair price for their properties, plants, equipment, etc., as decided upon by an unbiased board of appraisers; second, it is probable that 5 per cent. sinking fund bonds would be floated with which to make the purchase; third, these properties must continue to pay a certain revenue into the state and county treasuries as it would be flagrantly unfair to other taxpayers to be forced to meet the deficit which would be created by the withdrawal of the taxes paid by the coal mining concerns.

Thus we see that the government would enter into the coal mining business with an initial handicap of 5 per cent. annually, plus a sinking fund, on a correct present valuation of its properties. It would be burdened with the same tax assessment as the individual operator, and would possess no advantage over

him except the decidedly doubtful one of complete monopoly.

When we consider the painfully small dividends which have been earned during recent years by the coal mining concerns of America, in most cases on a capital stock of far less than their present real value; when we consider the number of forced sales and receiverships; when we consider that the majority of the present mine owners have made coal mining their life study and are, therefore, fully cognizant of the most efficient and economical methods of extraction, preparation, and sale; when we consider that if coal mining were a government industry that popularity-mad politicians, playing for the approbation of the conservationist element, would probably force more expensive mining methods in the mistaken interests of cleaner extraction; when we consider the natural mounting of the cost figure due to the exhaustion of the more accessible seams, we are irresistibly forced to the conclusion that it would be next to impossible for the government long to mine coal and place it on the market at the present normal quotations and maintain the same wage scale.

One of two things would be necessary, a reduction in wages or an increase in price.

It has been previously remarked that it is characteristic of the American voter to treat with indifference legislation which does not affect his individual interests, but when it does affect him, and does so adversely, his indifference is simultaneously transformed into active and vigorous protest, and this alone would render an increase in price clearly impossible. It would be quite possible for a politician to attain office on the single issue of "cheaper coal" and no department head would risk political oblivion by ordering an increase in the selling price, therefore the inevitable alternative is to offend the numerically inferior class and order a reduction in wages.

And with the United States Army back of the order, a strike would be worse than useless; for, while between operator and union the government listens to the arguments of both sides and endeavors to mediate, between government and union it must necessarily uphold its own contentions.

Another point to be considered is that the activity of conservation cranks would probably necessitate the withdrawal of all export trade, thus appreciably lowering the required tonnage with a corresponding reduction in the opportunity for labor.

What then, to recapitulate, could the American miner reasonably expect from government ownership? A uniform wage scale at a reduced wage, a reduction in the amount of available work to be done, absolute loss of recourse in case of injustice on the part of employer as to price paid per unit of work, condition of tenements, or prices charged in government stores.

In other words, the assumption of control of the coal mines of America at the instigation of America's mine workers, would mark the final signing away of their liberties and the beginning of a period of serfdom of which Russia could boast no better example.

Turning Rooms at Angles Other Than Right Angles

The accompanying diagram, Fig. 1, while primarily intended to be used by the mining engineer in setting points for rooms when turned from an entry at any angle other than a right angle, can also be used in solving the sides of a triangle when one side and one of the acute angles are given.

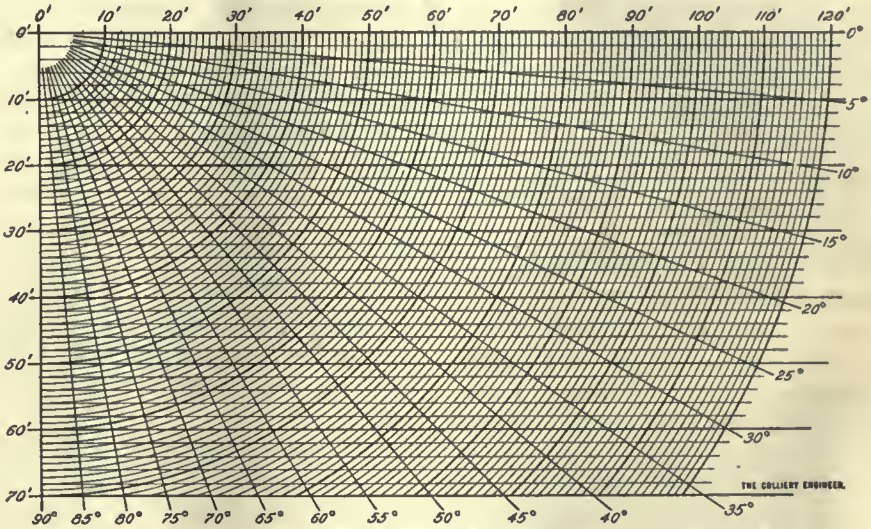


Fig. 1. Diagram for Turning Rooms at Angles Other Than Right Angles

To set points for rooms to be driven from an entry at any angle: Given the distances between centers at right angles. Referring to Fig. 2, let ab = 50 feet, the angle cdb = 30°; then pick out 50′ on the vertical line to the left of diagram Fig. 1 and follow the horizontal line until it intersects the slant line 30°. Follow the curved line from this point to the top horizontal line and pick off the distance; in this case it is 99 feet.

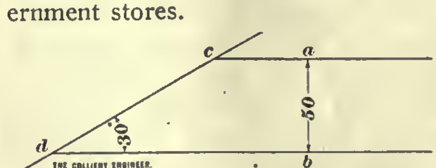


Fig. 2

If the same idea is followed, either the hypotenuse or base of any right triangle can be found. The hypotenuse is taken from the slant lines and base from horizontal lines.

S. Graff Haverstick

Frostburg, Md.

William Murdock lighted his house with gas from coal in 1792, he fitted up a gas making machine at Soho in 1798, and illuminated Boulton and Watts factory in 1802. Mr. Winsor established the first public gas lamps in Pall Mall about the year 1805.

OBITUARY

WILLIAM ARNOTT WILSON

William Arnott Wilson died at Saint Francis Hospital, Pittsburg, Pa., March 5. He was born at Plymouth, Pa., in 1867, and was the descendant of persons of great prominence in Colonial and Revolutionary history. He was educated by private tutors at his home at Plymouth. Mr. Wilson, in 1898, married Cecelia G. Donohoe, a daughter of the late Thomas Donohoe, of Greensburg, Pa. No children resulted from this union, and he is survived only by his widow and five sisters. He began his professional life as a civil and mining engineer with the Lehigh Valley Railroad. He went to Greensburg, Pa., in 1891 as chief mining engineer for the independent coal companies which have since been merged into the Keystone Coal and Coke Co. Together with his father-in-law, in 1898, he organized and built the property of the Donohoe Coke Co. In 1901 he organized the Mount Pleasant Coke Co., following this by the organization of the Veteran Coke Co. and the Mount Pleasant Connellsville Coke Co. Of the latter three companies, he had always been the manager and principal owner. He also placed a coking operation on a property of the estate of the late William Thaw, of Pittsburg, Pa. He was a man of very domestic habits, but was socially prominent. He was the soul of honor in all of his business transactions and never had, at any time, the slightest labor trouble. He was a man of exceptionally keen intellect of great tenacity of purpose, very well read, and kept thoroughly abreast of all the important questions of the day. In his untimely death the state suffers a loss, as it was his intention to retire from active business in a few years and, following the example of his ancestors, to devote himself to the service of the state, a career for which he was eminently fitted by reason of his intellect, honesty of purpose, clean character and wealth. He was buried March 9, from the Catholic Church, in Greensburg, Pa.

MAJOR THOMAS DAUGHERTY

Major Thomas Daugherty, a member of the one-time firm of George H. Myers & Co., for many years prominent operators in the Lehigh region of Pennsylvania, died at his home at Allentown, Pa., on February 22, aged 78 years.

Major Daugherty was one of the best known men in the Lehigh region. He was born in Beaver Meadows, Carbon County, Pa. In 1853 he became a member of the engineer corps engaged in the construction of the Lehigh Valley Railroad and was engaged in that work until the completion of the road in 1856.

Early in the year 1859, he went west, crossing the plains from Leavenworth, Kans., to Denver, Colo., with an ox team. In Coloardo he spent 2 years prospecting and mining, and during the winter of 1859–60 he served as assistant clerk of the Colorado Legislature, and later he taught the first school in the territory, at Golden. When the Civil War broke out, in 1861, he entered the service of the United States and rendered distinguished service, and had many unique experiences. On March 26, 1863, he was mustered out of the service with his entire company. The following year he became bookkeeper at the Yorktown colliery and continued in that position for 30 years, during the last eight of which he was a member of the firm of George H. Myers & Co. Major Daugherty is survived by his widow, who was Miss Janet Hewett, of Brooklyn Centre, Susquehanna County, Pa., and the following sons and daughters: George H., of Allentown, Pa.; Nellie, wife of Charles F. Huber, president and general manager of the Lehigh & Wilkes-Barre Coal Co., Wilkes-Barre, Pa.; Abel H., of Bethlehem, Pa.; and Julia E., wife of W. A. Pollock, of Allentown, Pa.

Telephones for Oklahoma Mines

The Oklahoma Coal Operators' Association through its representative, Carl Scholz, president of the Coal Valley Mining Co., has awarded its contract for mine telephones to the Western Electric Co. Eight hundred of the company's standard mine telephones with complete wiring and installing material are included in this order which is the largest ever placed at any one time for such equipment.

The various mines, whose operators are members of the association, will each be furnished with sufficient telephone equipment to properly safeguard the lives of the miners at work underground. Telephones will be installed in the shotfirers' refuge holes, in entries and shafts. Constant communication with the offices at the surface will be possible, and in this way, accidents can be reported promptly and proper aid sent to the danger point at once.

Also the shot firers, whose duty it is to enter the mines after the miners have left and explode the charges which will throw down the coal to be mined the next day, will report their progress according to a prearranged schedule. Failure to report from any one refuge hole on schedule time will serve as an indication of a possible accident and immediate steps can then be taken to effect a rescue.

While the installation of the large quantity of mine telephones will be made primarily as a result of a law enacted a short time ago by the legislature of Oklahoma making it compulsory for mine operators to equip their mines with telephones, the installations will undoubtedly be instrumental in increasing the efficiency of mine supervision as well as safeguarding the lives of the workers. They will make it possible for the superintendents to keep in touch with their mine bosses every minute of the working day and in this way tend to produce a better spirit of cooperation in the operating forces.

WITH THE EDITORS

A NEW method of acknowledging subscription remittances becomes effective April 1. After this date receipts will not be sent to subscribers unless expressly requested. On receipt of subscription payment, the date of expiration appearing on the mailing wrapper will be changed to show the date to which the subscription has been renewed.

Explosion at Layland

AN EXPLOSION occurred on March 2 at the Layland mines of the New River and Pocahontas Coal Co. About 160 men were in the mine at the time and 47 of these were rescued, while probably 111 were killed. In most cases death was due to the effects of afterdamp, and the survival of those who escaped death was due to the fact that they remained in cross-entries and built stoppings to protect themselves from the afterdamp which was passing along the main entry. It is not possible at this date (March 15) to make a statement concerning the cause of the explosion.

Excellent work was done by the State Mine Inspectors, local men, and the officers of the company, the rescue crew from Gary, and the forces of the United States Bureau of Mines.

Overdoing Safety First

THE "Safety-First" movement indicates a great change in industrial life, the humanizing of industry. Sometimes we wonder what is coming over the world when we realize how much employers are actually and honestly doing to make their employes happy and keep them well and whole. It is because the movement is so good and its success is so important that a criticism of one phase of it is offered.

Not long ago a visitor was passing through one of our largest steel plants. The officer of the company who accompanied him was especially pleased by his commendation of the care that was being exercised to prevent accident. Wherever there was probability that any lack of care might result in injury, was the warning "Safety First," plain, bold, compelling. It would seem that the constant insistance of the appeal would impress itself on any one and make him careful.

But there was one sign that especially caught the attention; it was placed where a railroad track ran close to a wall, and said: "Danger! Side of Car Will Not Clear Man." Now the impressive thing about this sign was the fact that the side of a car would clear a man. The space was not large, but it was large enough for a man to escape crushing. Would not the ordinary man take a chance in such a case? Would he not see that there was less danger than the sign implied? And if he found that one sign exaggerated the danger, would he not have less regard for the others? There is an old story of a boy who cried "Wolf! Wolf!"

This "Safety-First" movement is something important, even precious. It deserves all possible care and attention. Therefore this suggestion that warnings that are inaccurate, wrongly placed, or so numerous as to become commonplace, may do harm.

Coal Miners as Soldiers

A RECENT news item states that Lord Kitchener, the great British soldier, has in the course of his service become deeply impressed with the value of the Northumbrian coal miner as a military asset. His good opinion is founded on the work done in the field by the Northumbrian Fusileers. He told Lord Grey that he wanted more men of the same class for the new forces which he is organizing.

It is more than probable that the Kaiser's generals, if asked, would speak equally as highly of the German recruits from Silesia and other German coal regions, and that General Joffre, the French commander, would as highly commend the French miners.

What Lord Kitchener has learned during the past 6 months regarding coal miners as soldiers was learned by the United States Government over 50 years ago.

In 1861, when the Civil War began, Schuylkill County, Pa., was the greatest coal producing county in the United States. In response to President Lincoln's call for volunteers to defend the national capital, among the first five companies to respond were two from Schuylkill County, which were composed largely of coal miners. These two companies, with the other three, are honorably known as the "First Defenders." As the war grew in magnitude, all the then developed coal fields of the North furnished coal miner volunteers, who acquitted themselves nobly; Schuylkill County during the Civil War period, which was two to one Democratic in politics, and therefore of opposite political faith to the administration, sent, in proportion to population, more men to defend the Union than any other county in the United States.

Among the men contributed by that county were the 48th, 50th, 96th, and 129th regiments of Pennsylvania

Volunteers. These regiments were recruited entirely in the county, and there were thousands of Schuylkill countians enlisted in other regiments. Luzerne, Carbon, and other anthracite mining counties did almost as well as Schuylkill, and every developed bituminous coal field in the North sent large numbers of volunteers.

The four regiments specifically mentioned made records during the war that were unsurpassed by any other regiments in the great Northern army. The 48th, which entered the war under Colonel Nagle, afterwards promoted to a brigadier generalship, had as its next commander Col. George Gowen, who was killed in action. Colonel Gowen was succeeded by Col. Henry Pleasants, later brevetted brigadier general, who in turn was succeeded by Col. J. K. Seigfried, later promoted to a brigadier generalship. It was while under the command of Colonel Pleasants that the 48th regiment undermined the Confederate fortifications at Petersburg, Va., and blew them up. This, for that time, great work, was originated by Colonel Pleasants, who was a mining engineer, and it was accomplished under difficulties and dangers that would have appalled and disheartened any but a regiment of coal miners. While the other regiments mentioned did not have the distinction of doing the mining work that the 48th had, they made equally as brilliant records in many fiercely contested battles, during which hand to hand fighting, and not long range artillery duels, were predominating features.

PERSONALS

James G. Furie, of Rockford, Pa., has accepted the position of superintendent of mines for the B. J. Lynch Co., of Meyersdale, Pa.

Dr. Henry M. Payne, consulting engineer, of New York City, has recently been made consulting engineer to the Canadian Klondyke Mining Co., and starts April 1 for Dawson, Yukon Territory, where he will spend the season.

About fifty of the most prominent retail coal dealers of Chicago and a few from other points in the Middle West were guests of the C. & O. Railway and the sales agencies and operators of the New River field recently. Four days were spent inspecting the mines in this field. The itinerary included Loop Creek, Piney Branch, Winding Gulf, and other points on the C. & O. lines in the New River field, and many operations were visited and inspected.

Y. Kusakabe, who some time ago visited the mining regions of the United States, has returned home and been assigned to Takashima coal mines, Nagasaki, Japan.

T. R. Johns has resigned his position as superintendent of the Ebenburgh Coal Co.'s mine at Colover, Pa. Mr. Johns has held this position for a number of years and the mine has been shipping 4,000 tons daily.

The office of the Buffalo & Susquehanna Coal Co. will be moved to Du Bois, Pa. The following officers were recently elected: James R. Casely, president and general manager; Ganson Depew, vice-president; T. J. Elmer, auditor; F. A. Lehr, secretary and treasurer.

The Heating Value of Illinois Coals*

The heating value of Illinois coals relative to their ash was investigated by the Chief Engineer of the Commonwealth Edison Co., and curves charted.

The curves show that coal having 35 to 40 per cent. ash, although it contains from 2,000 to 3,000 B. T. U. is worthless for steaming purposes. As the average ash in Illinois coal is from 15 to 20 per cent. the rate in loss in fuel value is represented by a reduction of 5 per cent. in price for each 1 per cent. ash above these averages. In comparing bids, the ash, calorific value, and price per ton are merged to ascertain the number of B. T. U. furnished for 1 cent. The United States Bureau of Mines has devised the following equation in which the inverse ratio between the ash and the calorific value has been maintained and reflected in the cost of heating value for a standard commercial unit:

$$V = \frac{TU}{p - \frac{(A-G)p}{E}}$$

In this equation T = ton of 2,000 pounds; U = B. T. U. per pound guaranteed by bidders; p = price per ton in cents; A = maximum ash allowed; G = per cent. ash guaranteed by bidder; E = per cent. of ash when the value of coal disappears = 40 per cent.

To illustrate the significance of the equation the following bids for run-of-mine coal are used, the delivery being by cars:

Bids	Price Per Ton	Guaranteed Ash Maximum	Guaranteed B. T. U. Minimum
A	$2.00	13 per cent.	11,500
B	1.70	15 per cent.	11,000
C	1.60	15 per cent.	11,500

Bid A, by the equation gives 121,000 B. T. U. for 1 cent.

Bid B, by the equation gives 129,400 B. T. U. for 1 cent.

Bid C, by the formula gives 143,800 B. T. U. for 1 cent.

Compared with coal C, coal A is worth but $1.90.

Coal B is similar in ash with coal C but has 500 less B. T. U., consequently on a basis of 1 per cent. for each 100 B. T. U. the value of coal B is lowered by 5 per cent. or 8½ cents to $1.62½ per ton as its relative value.

Thus the coal A is overrated 10 cents per ton by bidder A, and coal B, 8½ cents a ton by bidder B. As coal C contains 143,800 B. T. U. for 1 cent the bidder C receives the contract.

*Abstracted from paper on "The Testing of Coal for Purchase," by J. M. Goldman, M. E., Consulting Engineer, Boatmans Bank Building, St. Louis.

Loaded mine cars will slide on rails, even with four sprags, on a 7-per-cent. grade. A down grade should not be more than 5 per cent.

Southwark-Rateau Centrifugal Pumps

Adaptation of Centrifugal Pumps to Handling Water Containing a Large Proportion of Solids—Method of Balancing End Thrust

Written for The Colliery Engineer

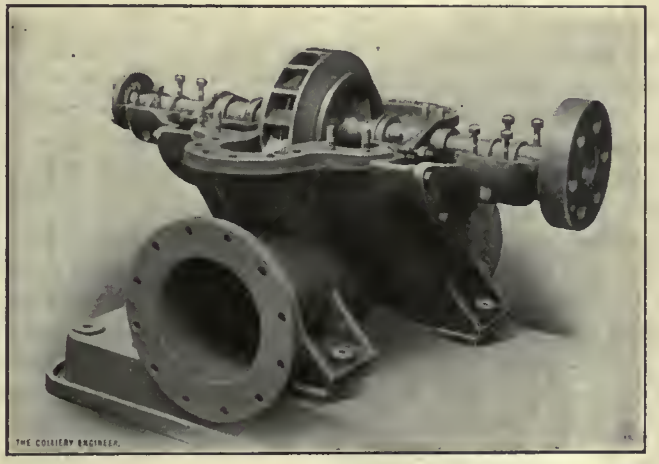


Fig. 1. Single-Stage Double-Suction Centrifugal Pump

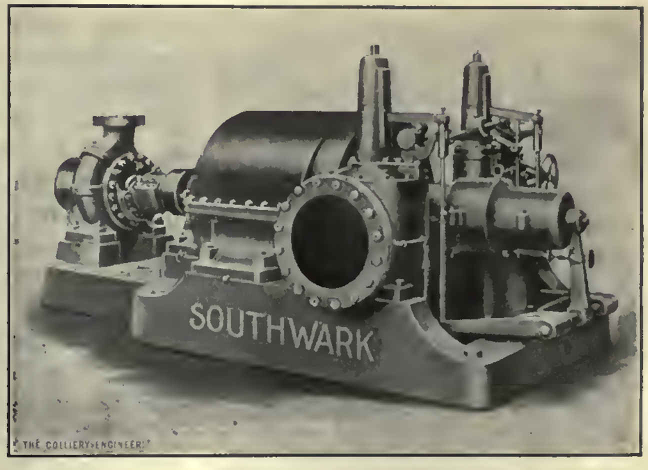


Fig. 2. Low-Pressure Steam Turbine Driving Single-Stage Pump

When the articles on centrifugal pumps that appeared in the February and March issues of The Colliery Engineer were written, a description of the Rateau pumps was not available. Recently photographs of these pumps were obtained from the Southwark Foundry and Machine Co., the owners of the Rateau patents in this country, and a brief description of them follows.

In the March issue allusion was made to an unknown person in California being the inventor of the multistage centrifugal pump; now it is claimed that M. Rateau was the inventor. However that may be, multistage pumps were first manufactured in this country and placed on the market by some firm in California. It is stated that M. Rateau obtained a discharge head of 1,000 feet from a single-stage pump rotating at the rate of 18,000 revolutions per minute. Realizing this speed to be impracticable with a single impeller, M. Rateau conceived the idea of the multistage pump where the pressure head from one impeller was transmitted to a second impeller and this compounded and the doubled pressure delivered to a third, and so on.

In Fig. 1 a single-stage double-suction centrifugal pump is shown with the cover removed. This pump is nicely balanced so that practically no thrust comes on the journal boxes, which are oil lubricated. The diameter of the intake, it will be seen, is almost as great as the diameter of the impeller.

Illustrating the usefulness of centrifugal pumps, take New Orleans, which is below the level of the Mississippi River and consequently had to adopt some system that would lift large quantities of sewerage over the dike so it would flow into the river. After deliberation and experimentation, centrifugal pumps were adopted on account of the large quantities of water they can lift and because any solid that can enter the impeller can be passed through the pump.

Where coal is stored under water, centrifugal pumps have been used to lift it from the pits and they have been and are used to advantage in river dredging for anthracite.*

Multistage pumps have their impellers arranged in series and in this way increased pressure is obtained at the expense of volume. When, however, the impellers are arranged in parallel increased volume is obtained but not so much pressure as when in series.

In Fig. 3 three impellers are shown arranged in parallel so that they can all deliver to one pipe or to three pipes. Each side of the central impeller there are journal boxes to prevent any spring of the shaft, also it will be noticed that each impeller has a double suction in order to prevent end thrust. If a three-stage pump were run at a given number of revolutions, it would deliver a certain volume of water to a moderate height with three times the pressure of three impellers working in parallel, but the impellers working parallel would throw three times the water to the same height, although it would

*See The Colliery Engineer, Vol. XXXV, October, 1914, p. 113.

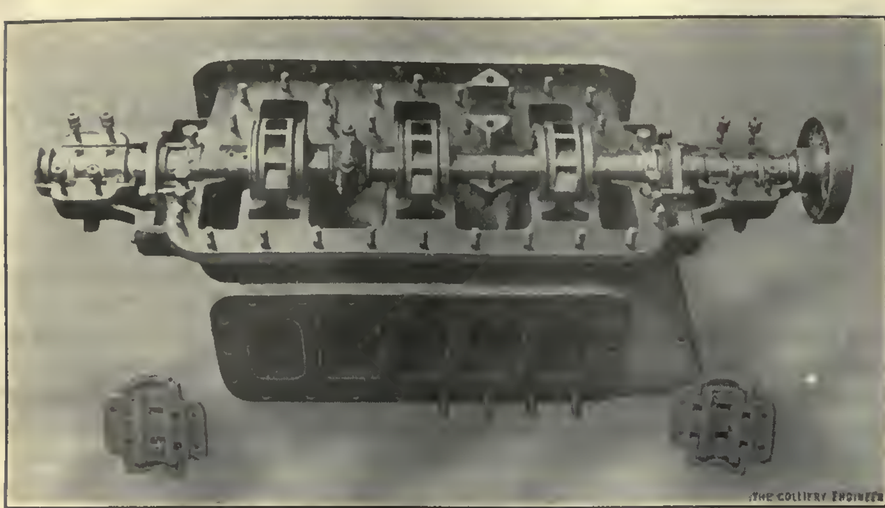


Fig. 3. Multistage Southwark Pump

spout with but one-third the pressure.

Since the steam turbine has found favor with centrifugal pump manufacturers, it was only a question of time when the exhaust-steam or low-pressure turbine would be adopted. Fig. 2 shows a low-pressure turbine coupled direct to a single-stage pump. This machine is regulated automatically and is said to give entire satisfaction.

The three-stage centrifugal pump shown in Fig. 4, to the right, is capable of delivering 1,200 gallons per minute with a discharge head of 500 feet. It is driven by a steam turbine and attains an efficiency of 800 per cent. Pumps of this description are constructed to pump hot water, in fact, make excellent boiler feed-pumps because when once adjusted for quantity they require little attention. In order to prevent vaporization of the hot water a helicoidal arrangement has been adopted that makes it possible to pump hot water of any desired temperature.

Comparison of the size of intake and exhaust pipes for the steam and water ends of the combination, shows that the exhaust of the turbine must be larger while the delivery from the pump must be smaller than the intakes. In the steam turbine, pressure is converted into velocity; in the multistage pump velocity is converted into pressure, thus reversing conditions. The machines are so well adapted to each other that an efficiency of 80 per cent. has been recorded. This multistage pump is balanced, to prevent end thrust, not by marine journal bearings, however, but by hydraulic pressure that is applied to a plate on the shaft so as to oppose the pressure head and incoming water. In Fig. 5 is shown a horizontal cross-section of the pump in Fig. 4. To the right at the entrance to the first impeller is the helicoid, to the back of the last impeller is the pressure plate. It would seem from the illustrations as if this was a large pump, when as a matter of fact it does not look over 2 feet long and about 18 inches in diameter. When pressure is above 500 pounds per square inch the balancing plate could be used, but friction is reduced by making use of the double suction, that is, a suction pipe is placed at each end of the pump, thus making the thrusts from the incoming water meet centrally and balance.

Where double suction is adopted the pump impellers are arranged in series-parallel, the number of impellers being 3, 5, 7, etc., the odd number impeller being central in the pump to receive the water from the pumps each side and deliver it to the column pipe.

If, for example, there was a three-stage pump there would be five impellers, two on the right and two on the left of the central impeller. The water entering the fifth impeller would have the same pressure and velocity from each side so that thrust would be balanced.

The flexibility in arranging centrifugal pumps and also in driving them has added almost as much to their usefulness as did the series arrangement of impellers for obtaining pressure, and when their adaptability to the different kinds of power available about mines is considered it seems as if in the future they must supplant piston pumps in mine drainage and find new sources of usefulness about mines heretofore considered impracticable on account of the expense connected with the use of another kind of pump. For fighting mine fires a small multistage centrifugal, motor-driven pump mounted on a truck will prove of great assistance, because it will furnish pressure to throw water where it would be dangerous for men to go with chemical engines.

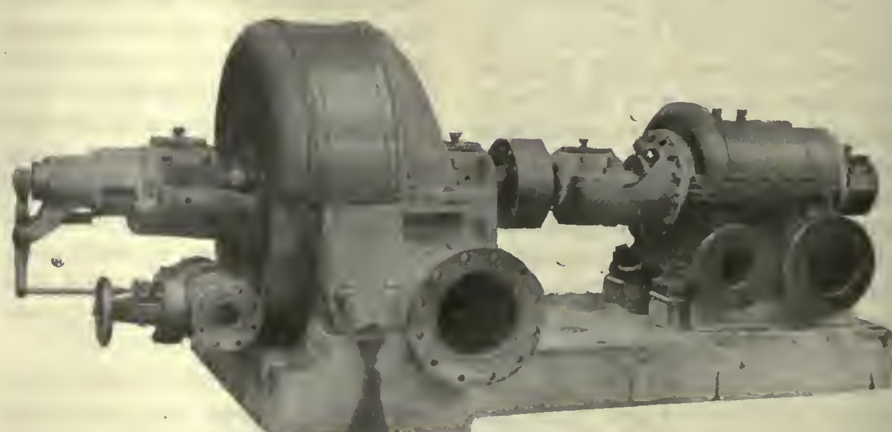


Fig. 4. Three-Stage Centrifugal Pump Driven by Steam Turbine

Centrifugal pumps are driven directly by, or belted to, steam engines, electric motors, steam turbines, or exhaust steam turbines, and, because of the simple rotary motion used to drive them, they are sure to be used more extensively in the future than in the past. To those who carry in mind the paddle wheels used in the earlier centrifugal pumps, attention is directed to these being replaced by impellers which have their blades enclosed to make the passage of water through them positive and free from friction.

Legal Decisions on Mining Questions

Conveyance of Underlying Coal. (West Virginia) The West Virginia Code of 1913, Section 3920, provides that the owner or tenant of any coal lands shall not remove coal from within 5 feet of the line dividing said land from that of another, without the written consent of every person interested in, or having title to, such adjoining lands. Under this section of the law, a deed conveying coal land, giving the grantee "all the usual mining privileges for the removal of same and every part thereof from under and in said parcel of land, such as are vested in the parties of the first part," does not authorize the grantee to mine the coal within 5 feet of the dividing line between the grantors and the grantee.—*Darby vs. Davis Coal and Coke Co., 81 S. E. 1124.*

Lease of Oil Land.—(Texas) Contracts in which land is leased for development for oil are to be construed most favorable to the lessor, and, in order to preserve its rights, the lessee must begin performance within a reasonable time, and continue performance with reasonable diligence; for the reason that discovery and production of oil is a condition precedent to the continuance or vesting of any estate in the premises, that such operations make the land less valuable for agriculture and, if delayed, result merely in speculation.—*Owens vs. Corsicanna Petroleum Co., 169 S. W. 192.*

Contract to Furnish Electric Current.—(Federal, Alaska) A written contract by the owner of an electric power plant to furnish at its power house "a current of not to exceed 300 electric horsepower" for a consideration received cannot be construed to require the furnishing of three or more times such current when necessary to start a certain type of motor, although such motors were in use by the other party when the contract was made, and it was known that the current was to be used for their operation, but the necessity of a large additional current for starting purposes was not anticipated or thought of by either party.—*Alaska Treadwell Gold Mining Co. vs. Alaska Gastineau M. Co., 214 Fed. 718.*

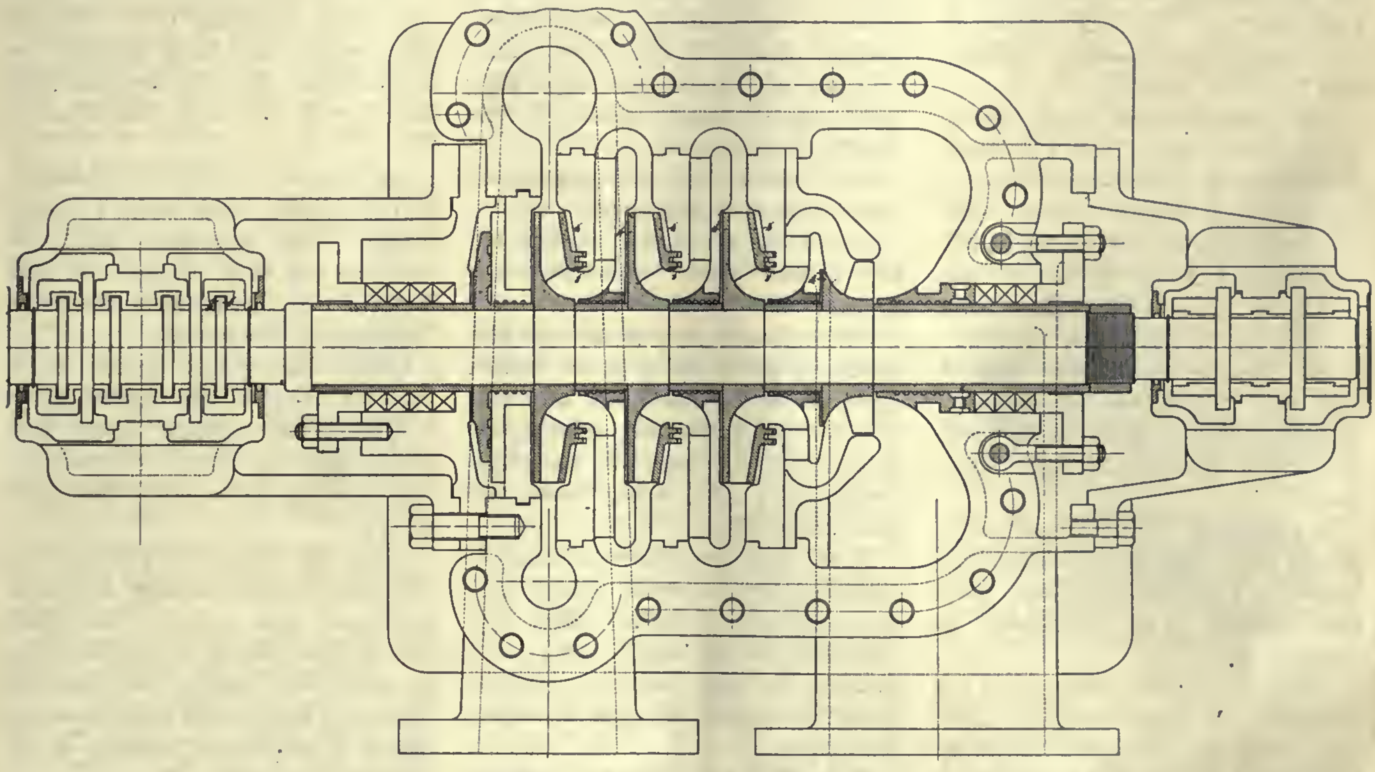


Fig. 5. Horizontal Cross-Section of Pump Shown in Fig. 4

Correction

In the March issue of The Colliery Engineer, page 414, second column, the answer to the problem on cost of pumping should be $69.81 instead of 56 cents.

If the price of current is more than one cent per kilowatt hour, multiply the $69.81 by that price in cents.

For a lift of 100 feet the following remarks will apply: 100 per cent. efficiency would cost $2,293.04 × .72 = $1,650. For any other efficiency divide $1,650 by that efficiency and obtain the cost direct.

Plant of Yellow Creek Coal Co.

In the Cumberland Gap, Kentucky, Coal Field—Description of the Coal and the Methods of Preparation

*By R. J. Sampson**

THE mines of the Yellow Creek Coal Co. are located at Bosworth, Bell County, Ky., in the Cumberland Gap coal field. They are some 5 miles west of Middlesboro, almost on the state line between Kentucky and Tennessee, and are reached by a branch of the Louisville & Nashville Railroad, over which the Southern Railway also has track rights.

The company first began operations in the Poplar Lick and Sandstone Parting seams—these two being opened at the same time. Coal was first shipped in January, 1902. Operations were carried on in these two seams alone until 1912, when a seam some 750 feet below the Sandstone Parting coal was opened. This has not yet been satisfactorily correlated, but is believed by some authorities to be the Straight Creek seam.

Development of the Dean seam, on the north side of the cañon, was begun in 1913, and shipment from this opening was commenced in January, 1914.

The Poplar Lick seam lies at an elevation of approximately 2,500 feet above sea level and shows at this point a section of 4 feet 6 inches of clean coal of the following composition: Moisture, 4.46; volatile matter, 33.57; fixed carbon, 60.12; ash, 1.43; sulphur, .52.

The Sandstone Parting coal, some 700 feet below the Poplar Lick, has here an average thickness of 48 inches. One foot from the bottom there is a sandstone parting, from 4 inches to 5 inches thick.

Analysis of the Sandstone Parting coal is as follows: Moisture, 2; volatile matter, 33; fixed carbon, 57; ash, 7.20; sulphur, .55.

The Dean seam is here 4 feet 2 inches thick and is clean, with the exception of a very thin stratum of soft clay near the top. No analysis of the Dean seam in this locality is available.

The lower, or "stray" seam, has a thickness of 36 inches of clean coal.

Some 40 feet above the Poplar Lick, is the Klondike seam, whose average thickness is about 4 feet 6 inches, with a shale parting 2 feet from the bottom, which varies greatly in thickness.

The Yellow Creek Co. has as yet done no work in this seam.

All of the mines are worked on the double entry room-and-pillar system.

On the south side, in the two old mines the air is not split, but in the lower mine on that side and the mine on the north side, splitting of the air is accomplished by means of overcasts, a split being made for each cross-entry.

In the two new mines the coal is undercut by short-wall chain cutters, one Jeffrey, one Goodman, and two Sullivan machines having been installed for this purpose. At the other two mines the coal is mined with picks.

Three 7½-ton Goodman electric locomotives haul the coal.

From the Poplar Lick seam the coal is lowered by means of a retarding conveyer of the rope-disk type, having a capacity of 100 tons per hour. This discharges into a bin from which the coal, together with that from the Sandstone Parting seam, is loaded into 8-ton monitors. These also carry the coal from the lower seam.

On the other side of the cañon, monitors also handle the coal, carrying it to the same tipple as that from the south side, but into a different dump. All of the coal passes over the same screens.

For several years previous to 1914 the company had a contract with the Southern Railway which covered their entire output. This contract, however, expired in June, 1914, and since then this coal has been on the open market.

Immediately under the lower seam there is a stratum of clay which comes up with the coal. This, together with the sandstone parting, made it imperative that the coals be mechanically washed. To accomplish this, a washery has been erected which has a daily capacity of 1,200 tons. This is the largest and most complete coal washing plant which has been installed in this section. It was designed and built by the Pittsburg Coal Washer Co.

The Washery.—The coal is dumped as before and passes over a 4-inch screen. The screenings go in a chute to the boot of the raw coal elevator. The oversize is loaded at the tipple as block coal.

Under the 4-inch screen is a 2½-inch screen. By means of a fly-gate, the oversize from this screen may be turned to the raw coal elevator or loaded at the tipple as egg.

From the raw coal elevator the coal passes down, through a retarding tower, into a bin. Two openings in the bottom of this bin, one on each side, supply raw coal to conveyers which feed two Pittsburg jigs of a guaranteed capacity of 50 tons per hour each.

From the jigs it is carried by the washed coal elevator to the screens, at the top. Waste from the jigs is carried by the refuse elevator to a chute which empties into a bin on the outside of the building.

Three grades, slack, nut, and egg, are made at the screens. The nut and egg sizes are lowered to the bins by means of spiral lowering chutes, which prevent breakage.

In case a run-of-mine product is desired, a chute is provided from the screens back to the tipple bins, which would carry all of the washed coal and load it with the block at the tipple track.

*712 Magoffin Ave., El Paso, Tex.

The washer bin gates are cast with a hollow rim, provided with openings for steam pipes. Steam is circulated through this rim, to prevent freezing of the water which, of course, collects at this, the lowest point.

The chutes just below the gates have openings in them, through which is passed the cleanest water available. The finer particles thus taken out pass into a hopper, then by means of a chute, to the sludge elevator, and thence to the sludge tank and the slack bin. The nut and egg sizes are loaded from the chutes by means of movable loaders.

The output is from 800 to 900 tons daily. To run the washer at its full capacity of 1,200 tons, an approximate output of 1,700 tons would be required.

The boiler house is equipped with two batteries of two 150-horsepower fire-tube boilers each.

In the engine room a 350-horsepower Ridgway duplex engine drives a 300-kilowatt General Electric generator by belt connection. A Houston-Stamwood 100-horsepower duplex engine supplies the power for the washery. It operates on 100 pounds pressure at the throttle. On each floor of the washery a shaft provided with clutches operates the machinery.

A camp of 250 comfortable cottages shelters 300 employes.

A well-stocked company store supplies the camp with all of the necessities and not a few of the luxuries of life.

The coals of this district are gradually getting into the market of the North and Northwest.

The opening of the Panama Canal should divert no little of the West Virginia coal which is now being shipped into the Northwest, thus creating a greater demand for the coals of this field, a demand which the operators are preparing to supply satisfactorily.

Osage orange wood is a source of dye and can be used to supplement the imported fustic wood, as a permanent yellow for textiles.

Fossils of Aid to the Coal Prospector

Grand Mesa, Colo., is a great coal bearing tableland rising about a mile above the general level of the country which lies to the south and west. The West Elk Mountains, near by, a group of peaks composed of igneous rock, rise to altitudes of over 13,000 feet above sea level and, together with Grand Mesa, form some of the most sublime and impressive scenery to be found in America. Much interest attaches to these mountains because of their mode of origin and because of their influence on the attitude of the coal beds and on the quality of the coal. Although now far above sea level, this area was beneath the ocean for a long time in the Cretaceous period. The sea was finally filled with sediments and great swamps were formed, in which vegetable matter accumulated as it is accumulating now in the Dismal Swamp, Virginia. The plants such as the figs and the palms, whose fossil remains are now found in the rocks, indicate that the climate of that time was about the same as the present climate of Florida or Louisiana. These beds of partly decayed vegetable matter were later covered by sand and mud and turned to coal. Still later these low lying beds were thrust up far above sea level, and great masses of molten rock rose from the earth's interior, some of them reaching the surface to form great volcanoes, while others found lodgment within the sediments and there consolidated into great masses of resistant rock many thousands of feet thick. These masses that did not reach the surface are known as laccoliths.

Some of the sedimentary rocks containing the coal beds were bowed up over the laccoliths and others lie beneath them. The softer rocks near the surface have since been eroded and the laccoliths now stand as great masses of igneous rock, some of which are of impressive proportions and beautifully symmetrical in outline; others are carved by erosion into picturesque and fantastic forms. The disturbance of the sedimentary rocks and the heat from the molten rock that was intruded into them caused changes in the quality of the coal that are of great economic importance, some of it being transformed to an anthracite comparable to that of Pennsylvania.

An interesting description of this area is found in Bulletin 510, by Willis T. Lee, issued by the United States Geological Survey. The first part of the bulletin establishes the geologic relations of the coal bearing rocks, but the principal part is devoted to a description of the coal beds, their number, occurrence, thickness, etc. The quality of the coal at the several localities described is indicated by descriptions of its physical and chemical analyses. The coal varies from subbituminous and bituminous to anthracite. The largest producing mines are at Floresta, where anthracite is mined; at Crested Butte, where coking bituminous coal is produced; and at Mount Carbon and Somerset, where the coal is non-coking and bituminous. Several small mines are operating in the subbituminous coals, but most of the product is used for local consumption. It is estimated that this region contains more than 16,000,000,000 tons of coal in beds that are thick enough to be of commercial value.

A successful attempt is made in this bulletin to present technical data that are often regarded as useful only to the professional geologist in such a way that they can be used by a man who has no geologic training and who is interested mainly in knowing where coal is to be found and what quality of coal may be expected at a given locality. The rock formations are described, their appearance is illustrated by reproductions of photographs, and their outlines are mapped so that the coal bearing rocks can be readily recognized on the ground. Many sections showing the positions of the beds one above another, measured where the rocks are well exposed, indicate the horizons at which the several coal beds may be found. For ex-

ample, a conspicuous rock known locally as the basal or Rollins sandstone is easily recognized and may always be found a little below the best coals.

The fossils that occur at the several horizons are named in these sections; and in order that this information may be used in a practical way by men interested mainly in prospecting for the coal, illustrations of some of the more common ones are given. In the greater part of the region the presence of certain fossils indicates high-grade coal and the presence of certain others indicates low-grade coal. For example, if the prospector find an oyster shell like the one figured in this bulletin, in rocks near a coal bed, or a corbula which is likely to be found in shale just above a coal bed, he may be reasonably sure that his coal will prove to be bituminous coal of a relatively high grade. But if he finds in an area of undisturbed rocks certain clam shells (Unio), or snail shells (Tulotoma and Campeloma), or fossil leaves, which can be easily recognized by comparing them with the pictures in the bulletin, he may be reasonably certain that his coal is of relatively low grade and will slack on exposure to the air. However, in areas where the rocks have been disturbed and the coal metamorphosed, the fossils will be of little use to the prospector, for in such areas the coals are all high grade.

Heat Precipitation of Sediment

"Tests of comparative speeds of sediment settling from boiler feedwater at high and low temperatures, have shown conclusively that more effective sedimentation can be obtained in from 30 to 40 minutes at high temperature than can be obtained in 5 hours at a low temperature."—*Cochrane Leaflet No. 17.*

This is due to oxygen and carbon dioxide being driven from the water and to most chemical reactions being more rapid and complete in hot water than in cold. Most salts are more soluble in hot than cold water, therefore any precipitation occurring in hot water will be coarse and settle rapidly.

The Colorado Fuel and Iron Co.

The 1913–1914 report of the medical and sociological departments of the Colorado Fuel and Iron Co. has recently been issued. The work done by those departments in 1 year is remarkable.

Over 1,600 cases were treated at the company hospital at Pueblo. Almost 95,000 diseases were treated at the 30 camps or plants during the year.

The chief surgeon, R. W. Corwin, in his report to the president calls attention to several matters of interest to those concerned in hospital and welfare work, one of which is:

Welfare: First aid in camps; first aid in the schools; a rational athletic system; examinations of drinking water; effect of closing the saloon; the success of the moving picture show; the unit school house.

The last mentioned is probably one of the most vital. The completed unit plan contemplates a central double building and several single buildings on right and left of the central building, a basement for furnace room, lavatories, etc. For the sake of economy the partitions in the central building are movable so that the whole floor may be made into a hall. Since each district has many uses for a hall, this plan is admirable.

As more class room is demanded, additional single-room buildings are erected.

The cost of erecting such a plant is worthy of careful investigation. The unit plan is cheaper as well as better in every way. The lighter foundations, walls and supports; the absence of dead central spaces, for halls, stairs, and railings, make this form of school the most economical.

The advantages are: The number of schoolrooms may be made always to meet the demand, which is not the case with a building of many rooms. The many-room building is usually ahead or behind the needs of the district. There are vacant rooms intended for future requirements, or crowded rooms, waiting for the school board to build. The plan suggested admits of erecting a building or room when there is need for it, hence there is no room unused and none overcrowded. When several districts are crying for more room and the school treasury is low, the school board can accommodate each district at least cost.

There is less chance of fire and in case of fire there is less chance for loss of life or property or damage by water. There is no particular need of fire drill with its nervous strain on certain children, and the danger to pupils in case of fire is reduced to a minimum.

Light and ventilation may be obtained from any direction and there is less work for the janitor.

There are no stairs to climb up or fall down. This is a relief to the small child and of vital importance to the young girl.

There is no noise from the passing classes; it is easier for the principal to supervise grounds and rooms on this plan; the teacher finds the discipline of her class both in the room and on the playground easier, and there is greater field for individuality on the part of both teacher and pupil.

A five minutes' recess may be taken outdoors any time without disturbing other classes; the homelike atmosphere which may pervade the one-room building is not possible in the larger structure.

If life, health, and economy be worth considering, is there any excuse for still erecting the four-, eight-, twelve-, and sixteen-room building except the trouble of getting out of a rut?

The plan suggested here is so simple, inexpensive, and superior to the many-storied building, it would seem that it could but recommend itself favorably to architect, school board, and patron.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Mine Gases

Editor The Colliery Engineer:

Sir:—I have read with much interest Mr. Haas' article in the March issue, on the origin of mine gases. I am a purely practical man, and my experience causes me to support Mr. Haas in some cases and contradict him in others.

We will go with Mr. Haas into the No. 8 seam of the Pittsburg measures, a seam overlying one of the greatest natural gas belts of the United States. This seam is frequently cut by clay veins and spars. It has a fireclay bottom and a soft shaley top. In some cases a large amount of natural gas finds its way into the workings. For example: the Enterprise and Midland mines of the Consolidation Coal Co. had been in operation for a number of years without any noticeable presence of firedamp, when on the morning of October 18, 1910, there was a gas explosion in these mines and a fire started in the Enterprise. This goes to support the opinion that the gas entered the mines through the underlying and overlying strata. My experience as a fire boss in that particular seam also gives sufficient evidence to support Mr. Haas' theory. I find that at times in the development of the mines we tap numerous feeders coming from the bottom, that there is always more or less gas present when clay veins and spars are encountered and that all bad faulty roof is also easily associated with the presence of gas.

I also find that some gas caps are more illuminating than others and some gases more rapid in their explosive properties than others, the gas sometimes exploding in the lamp at the same time that the cap begins to form; I believe that this may be due to the possible presence of carbon monoxide, heavy hydrocarbons, or possibly sulphuretted hydrogen. As coal tar is one of the products of coal and gasoline one of the products of coal tar, it would be reasonable to believe that ethene, C_2H_4, and ethane, C_2H_6, of the paraffin olefine series, gases which will liquify under certain conditions, are part of the constituents of the coal itself.

I find that the conditions existing in that coal field are of no practical value as a basis for conclusions concerning other localities.

My experience in the Kittaning seam leads me to believe that the gases met with there are confined to the coal, except on very rare occasions. One of these was at Glen White shaft No. 1, of the E. E. White Coal Co., where I found a gas in the Left Main entry that had the capping properties of marsh gas and a very disagreeable odor. This was given off from the overlying strata and brought much of the rock with it, the roof at this point being a broken sandstone.

In the Standard shaft of the Standard Pocahontas Coal Co., of Caples, W. Va., I know of a gas feeder that has been giving off gas for 2½ years. This has the appearance of being CH_4 mixing with the air as it escapes from the underlying strata. It will give a cap of 1½ inches at this writing. I also find numerous gas feeders from the strata underlying and overlying this, which is the Pocahontas No. 3 seam, there being two coal beds below and six above it. As there is no sandstone between the No. 3 seam and the No. 4, it is quite possible that the gas finds its way down through the various slates from the No. 4 seam to the No. 3, and that the feeders from the bottom may come from the No. 1 and No. 2 seams. We also find strong feeders coming out of the coal itself, and the coal gives off large quantities of gas on being heated.

My experience in the No. 4 Pocahontas leads me to believe that the gas belongs to the coal, as I have never located a feeder from either top or bottom. On one occasion in Coalwood shaft No. 1, operated by the Carter Coal Co., the roof in narrow entries began working as if there were an enormous pressure. Thinking that this was caused by gas from a 14-inch seam, the Pocahontas No. 5, I had holes drilled into the roof for 10 feet to 12 feet, the No. 5 seam being approximately 14 feet above the No. 4. There was a slight flow of gaseous matter from these holes, but it produced no visible effect on a safety lamp.

Wade C. Wales

Welch, W. Va.

Mine Gases

Editor The Colliery Engineer:

Sir:—Mr. Haas states that the man who has found CO with a safety lamp in a mine does not live to tell about it, even with a helmet. He is wrong. I have traveled over 1,700 feet with a helmet on and the reducing valve on the tanks bursted and not supplying me with much, if any, oxygen, and we had four sample bottles of the air taken at four different points in said 1,700 feet and each bottle showed 2 per cent. of CO. It was analyzed by Mr. George Burrell, of the United States Bureau of Mines. From what I have seen of lamps in CO, I believe about 3 per cent. could be detected with a safety lamp.

I believe the 2 per cent. was very poisonous and I was very lucky to get out, but the others that made the trip with me had no ill effects from the gas, and the only effect it had on

me was a feverish head and a sleepless night.

Mr. Haas also says that once a gas mixes with air it never separates. What is to keep it from separating? It is not a chemical compound. We know it will not separate while we have it in a strong current of air on the entry, but try to send said current of air and gas through old workings where the velocity is reduced and where high gobs are to be found and see if you do not find gas on some of the gobs after this charged current has passed by.

He must remember that a foreman does not move gas in a body, he dilutes it so that it is not dangerous, but it is often found explosive on gobs on the return of its passage and none was found on these gobs prior to the removal of this gas. I think this shows it will separate. If one throws a bucket of coal oil in a swift running stream he will not see it, but go to the wider places below and he will see traces of oil along the shore in still water. I believe this is simply because of its gravity—it is not chemically combined and that is my opinion of gas and air. J. R. C.

Elizabeth, Pa.

Gases in Coal Mines

Editor The Colliery Engineer:

SIR:—I am glad that Mr. Frank Haas is breaking loose from the steel bands of the old regretable decomposition theory. The theory advanced by Mr. Haas relative to gas working its way up through cracks in the rocks from gas strata 1,000 to 3,000 feet below and finding lodgment in the coal beds may be so. If, however, his theory is correct, then the lowest coal beds should be the most gaseous, but this is inconsistent with actual conditions in this Wyoming district; and I believe all experienced mining men will agree with me that the Baltimore, or the Pittston, bed is the most gaseous in this district. Of course the beds below are gaseous, but the Baltimore is full of gas pockets that form feeders or blowers, which oftentimes could be heard a long distance, and which were very difficult to contend with 20 or 30 years ago.

The Hillman bed, also, is very gaseous in some zones, and as the boys say, is very "firey," but in other zones there is little gas found.

Again, in other localities in this region, where the coal gives out a great quantity of methane gas, there are neighboring localities in the same bed, where no gas whatever is found, and yet lying in depth about the same distance below the river level. Hence, if the gas strata below are furnishing the coal with methane gas, why is it not uniform through the whole region, and why should not the lower beds be more gaseous than the middle beds? Again, when shafts are sunk through the rock strata, to the various beds of coal, gas is hardly ever found in the rock strata (unless some subterraneous, or hollow passage is struck) until the shaft comes near to the bed, then care must be taken to avoid an explosion, and so it is all the way down. The gas is found always in the bed of coal, but none in the rock. I have known of several holes that have been driven down below the lower beds of coal, but never found any gas that could be detected issuing from said holes.

I agree with Mr. Haas that the supposed vegetation forming these beds could not produce the quantity of gas developed by them, simply because it was not made from vegetable matter, and particularly anthracite beds.

As to the softness of the bituminous coal, and the idea that it can therefore absorb or contain a great quantity of gas, I will say that I had my early experience in some of the most gaseous beds in the bituminous localities of South Wales, but my experience has been that none of the beds ever gave off so large a quantity of gas as that of the anthracite Baltimore bed in the Wyoming region in years gone by.

W. D. OWENS, Div. Supt.,
Lehigh Valley Coal Co.

Forced Draft

Editor The Colliery Engineer:

SIR:—I have read Mine Manager's request for information regarding forced draft under boilers in THE COLLIERY ENGINEER for March.

Of course you know, with reference to the different styles of boilers that are on the market, that the water-tube boilers are the very best and most efficient for burning low-grade fuel.

I have had the care and use of several different types of water-tube boilers, and, for efficiency, rapid steaming and overrating, I believe that the two-drum type of boiler is the very best.

With reference to forced draft for burning low-grade fuel, there was a time when the jet steam blower was considered the very best and most efficient blower on the market for forced draft.

Under a battery of three 500-horsepower water-tube boilers, installed several years ago, and, when the jet steam blower was considered as the very best for forced draft, we placed four jet steam blowers under each boiler, twelve blowers in all.

By actual tests of these jet steam blowers, I found that they take from 19 to 21 horsepower each in steam to force the fires, or, on a battery of 3,500-horsepower boilers, I am using from 228 to 252 horsepower to force the fires.

Since the time of installation of these boilers, and the steam blowers, the turbine blowers have come on the market for forced draft, and they have proved to be the most efficient and most economical of any system, for forced draft.

The steel-plate fan equipment is also considered very good for forced draft, but, as the boiler plant would be dependent on one large steel-plate fan and engine for the entire set of boilers, if the fan, or its engine, breaks down, as has happened, and is liable to happen, the whole boiler plant is thrown out of business, until repairs are made.

With the turbine blowers in use, each boiler has its own individual

unit for forced draft, and, if one does play out, throwing one boiler out of commission, you have the other boilers still in service, and the turbine blowers operating them, will force the remaining boilers, to make up for the one boiler out of service.

We expect very soon to replace all our jet steam blowers with the turbine blowers.

One Who Has Used All Kinds
Scranton, Pa.

Forced Draft

Editor The Colliery Engineer:

Sir:—In reply to Mine Manager's question concerning mechanical blowers published in the March issue, I wish to say that in the first place, economy and simplicity must be taken into consideration and the efficiency of the system must be considered.

The steam jet blower is objectionable on account of the noise in the boiler room which above all things should be quiet. A blower whose turbine is in the circumference of the casing is not economical, for two reasons: First, the centrifugal action of the fan is not obtained, and it can only act as a three-quarter fan on the air, and three-quarter fans are considerably lower in efficiency than centrifugal fans; and in the second place, the cold air crowding through the turbine casing condenses the steam and more steam is used in condensation than is used to run the fan.

Select a type of blower with the turbine extended out in front of the fan and connected directly to the fan shaft, and with the blades of the fan curved and the casing expanded and shaped in such a manner as to obtain the centrifugal action of the fan on the air.

He will find a blower of this type advertised in The Colliery Engineer. Use an extra large furnace in the boiler, equipped with the old herring-bone grate bars, with at least 60 per cent. air space and $^{11}\!/_{16}$-inch mesh, unless he desires to install an improved shaking grate, but do not make the mistake of using small mesh grates with small fuel. A small fuel makes the most and largest ashes, and therefore requires the largest mesh in the grates.

It is the ash and solid part of the fire that lies next to the grate and not the fuel. Clinker does not form near as fast on large mesh grates as on small ones for the same rating.

If our friend installs the kind of furnace and blowers I advocate, and installs regulators or dampers in the stacks, he can operate the boilers on the balanced draft system. The dampers can be regulated in the stacks to balance the draft in the boiler furnace, so that no cold air can leak through the brickwork and cool the gases in the furnace. By this system the boiler plant can be operated with the utmost efficiency.

James Johnson,
Assistant Mine Foreman
Carnegie, Pa.

Ventilation

Editor The Colliery Engineer:

Sir:—Please publish the solution of the following problems:

1. If a volume of 5,000 cubic feet of firedamp, which contains 6 per cent. of marsh gas, and an equal volume of firedamp containing 9.5 per cent. marsh gas were combined, what would be the percentage of marsh gas in the mixture and what indications would it give on the flame of safety lamp?

2. What pressure is necessary to force 20,000 cubic feet of air through an airway 6 ft. x 14 ft. and 3,000 feet long? If the volume of air is increased to 20,300 cubic feet in the return airway, what percentage of marsh gas will it contain and what indications would it show on the flame of the safety lamp?

George Powell
California, Pa.

Ans. 1.—In the 6-per-cent. mixture you will have 6 per cent. of 5,000 cubic feet or 300 cubic feet of marsh gas. In the second mixture you will have 9.5 per cent. of 5,000 cubic feet or 475 cubic feet of marsh gas.

Combined you will have a total of 775 cubic feet of gas in the combined 10,000 cubic feet or a percentage of 7.75. There will be no indications on the flame of the safety lamp, because under ordinary conditions in so rich a mixture an explosion would result immediately. This you will realize when you think that a mixture of only 6 per cent. would give a flame of over 3 inches in the safety lamp.

Ans. 2.—In this case we suppose you mean the horsepower necessary to force the 20,000 cubic feet through the airway.

$$\text{H.P.} = \frac{k s q^3}{33{,}000\, a^3}$$

k = equals the coefficient friction = .0000000217;
s = rubbing surface;
q = volume;
a = area;

$$\text{H.P.} = \frac{.0000000217 \times 120{,}000 \times (20{,}000)^3}{33{,}000 \times (84)^3} = 1.06$$

In other words there is slightly more than 1 horsepower necessary to produce this current. The pressure necessary is found by the following formula:

$$P = \frac{33{,}000 \text{ horsepower}}{q}$$

$$P = \frac{33{,}000 \times 1.06}{20{,}000}$$

$$P = 1.76$$

This pressure is abnormal and indicates at once that the question is hypothetical.

Assuming the increase in volume, i. e., 300 cubic feet to be due to gas only, the total volume is 20,300 and 300 cubic feet of this is gas. Then the percentage is

$$\frac{300 \times 100}{20{,}300} = 1.5 \text{ per cent.}$$

The ordinary safety lamp, using oil as fuel, will not indicate the percentage of gas.

"Dead Hole"

Editor The Colliery Engineer:

Sir:—My own definition of a "dead hole" is as follows:

A dead hole is a hole where the coal lying outside of the powder, commonly termed the "heel" of the shot, offers less resistance than the coal at the "toe" of the hole, which is the common designation of the farthest end of the drill hole, meas-

ured at right angles to the direction of the hole.

The result of firing such a shot would obviously be that. the heel would blow out and the powder be blown into the working places, leaving the drill hole intact. It would then truly be a "dead" hole because it did not accomplish the work for which it was drilled.

CARL SCHOLZ

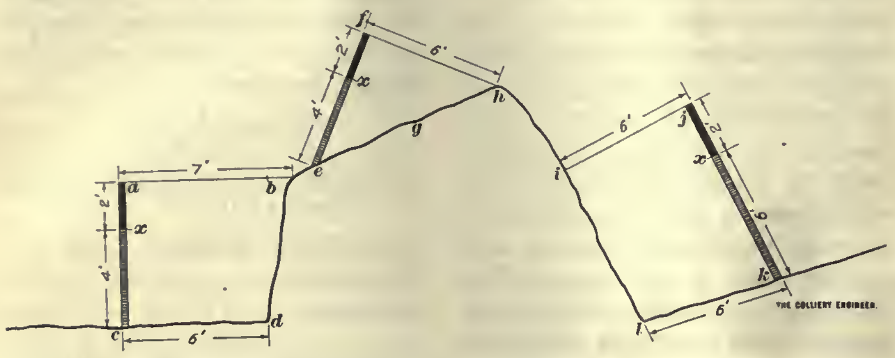


FIG. 1

Dead Hole

Editor The Colliery Engineer:

SIR:—I will try to explain the meaning of a dead hole according to the Illinois mine law, as requested by E. M. in your March issue.

The quantity of powder that may be used in one blast is limited by the law to the amount contained in five standard chargers, a standard charger being a cylinder 1½ inches in diameter and 12 inches long. This quantity would be spoken of by miners as "60 inches" of powder.

Referring to Fig. 1, from *a* to *b* is 6 feet and from *a* to *c* is 6 feet. In the 2½-inch drill hole *a c*, "60 inches" of powder will occupy the 2 feet *a x*, leaving 4 feet *x c* to be tamped; this part of the hole is termed the heel of the shot; and the part *x c d* not being enough to balance the part *a b d*, the hole would be termed a deal hole.

The hole *e f* would also be a dead hole, for the heel *x e g* would not balance the part *f h g*, and the powder working on the line of least resistance would break the coal at *x g*, causing a blown-out or windy shot.

A hole properly placed is shown at *j k*. The distance *i j* is 6 feet and the distance *j k* is 8 feet; with the powder occupying the 2 feet *j x* as before, the distance *x k* would be 6 feet and would balance the distance *i j*.

As a rule, the miners do not practice such strong shooting, for this is considered the limit. They prefer a 4½-foot heel with a 6-foot hole, using "50 inches" of powder, and find this surer and safer.

J. T. V.

Mine Workers and Booze

Editor The Colliery Engineer:

SIR:—I have read your editorial, "Mine Workers and Booze," in the March, 1915, number, and should like to comment on it.

I have been glad to see what an upright stand large coal corporations have taken regarding this early morning drink habit, and in fact the excessive drink habit, as a whole, in mining towns and camps.

In this town, I believe, a plan of campaign started in the proper way to eliminate this habit, would be a blessing to the family of the worker, the miners themselves, the coal operators, and the public in general: as there are at present about 25 saloons here, which have no hour for closing, or rather close when the last man is out of the place at night, and then are ready to open for the first man in the morning. This fact alone must be and is harmful to public interest and depressing to public morals.

Though danger of accidents from setting off gas by men having had too much drink are unknown in the Rock Springs field, yet in just such "no gas," "minimum danger" fields come at unexpected times some serious accidents. So with this in view and with the motto "Safety First" before us, why shouldn't the operators and the local unions take up the question in cooperation in a campaign to eliminate this early morning drink habit.

W. W. L.

Rock Springs, Wyo.

"Dead Hole"

Editor The Colliery Engineer:

SIR:—The illustrations, Fig. 2, have been prepared to illustrate a "dead hole." It will be seen that, in both plan and section, the shortest distance from the powder to a free face, that is the line of least resistance, is in the direction of the hole and not at right angles to that direction as it should be. Such a shot will not break the coal as it is intended to do, but will blow out. Some coal will probably go with the tamping, as is shown by the dotted lines. The hole should be placed nearer to a free face, so that the least resistance will be in the direction of the free face.

B. J.

Elevation

Plan

FIG. 2

Air for Methane Combustion

Editor The Colliery Engineer:

SIR:—Will some of your readers please answer the following question:

If 165 pounds of carbon dioxide is formed by an explosion of methane and air, what volume of air must have been present before the explosion to have furnished just enough oxygen for the complete combustion of the methane? Assume the temperature at 50° F. and the barometric pressure at 29.9 inches. Philip Davis

Virden, Ill.

Mine Workers and Booze

Editor The Colliery Engineer:

Sir:—When West Virginia became a prohibition state, considerable doubt was expressed regarding the way in which men would adhere to the letter and spirit of the law. The result so far has been satisfactory, for men of affairs who were accustomed to take a friendly "hoot" have become total abstainers. State Tax Commissioner F. O. Blue said that "the moral and beneficial effects of prohibition were apparent in mining towns of West Virginia, as well as in other towns and cities of the state." Some men have started savings accounts, others are making their homes attractive, and their wives and children more comfortable. Home life is making better men, better citizens, better husbands and fathers, and better workmen. Saloon frequenters before the prohibition law neglected their families, became poor citizens and poor workmen. There has been no falling off in the number of mine workers by reason of prohibition, and we believe it has been proved in Morgantown, which has been dry some years, that the most efficient class of labor in any industry is the sober class. Those who in our state were once opposed to prohibition are now in favor of it, but we believe that some arrangement must be made in every mining town to afford some kind of amusement for the men, especially the younger ones. This has been attended to in many cases and should be in all.

A New River Engineer

[We are pleased to hear of the improvements worked through the Prohibition Law in West Virginia. We would like to hear from others on the subject, as there is nothing equal to swapping experiences on matters of this kind. There are coal operators in other states who have opened club houses for their men where liquor and beer are sold in limited quantities. All profits from the sale are used for the benefit of the community, and while the operators do not approve of the plan, they have found it more satisfactory in their cases than having no liquor in the town.—Editor.]

Short Course in Coal Mining

This course of eight weeks duration from April 5 to May 28 at the Colorado School of Mines is established for the purpose of giving those men engaged in coal mining an opportunity to improve their work and benefit themselves and position. It is further designed to materially aid candidates for positions in coal mines, to pass the required state examinations under the laws regulating coal mines. No fees are charged for instruction. For further information, address Wm. G. Haldane, Acting President, Colorado School of Mines, Golden, Colo.

International Engineering Congress

Volume II of the transactions of the International Engineering Congress, 1915, to be held in San Francisco, September 20-25, will comprise two series of papers, one on the subject of waterways and one on irrigation.

The former subject will be treated under four general topics with possibly two additional if authors are found in sufficient time. These topics cover the general field of the province of waterways in internal commerce, economic aspects, physical features, natural waterways, towage, and propulsion.

The subject of waterways is one of great importance to the coal industry in some parts of the country. Membership in the Congress with the privilege of purchasing any or all of the volumes of the proceedings is open to all interested in engineering work. For full particulars apply to W. A. Cattell, Secretary, 417 Foxcroft Building, San Francisco, Calif., U. S. A.

Nystagmus (trembling of the eyes) of the Miners

About the important disease peculiar to miners, the trembling of the eyes, Dr. Johannes Ohm furnishes interesting information, based upon many years of study and research. The disease which, for some time, has been carefully watched in England, France, and Belgium, was heretofore not given the proper attention in Germany. Doctor Ohm, who has treated about 500 cases, figured that there are in the Bochum mining district alone about 11,500 miners who suffer with the trembling of the eyes. The symptoms are involuntary wave-like twitchings of the eye that may occur from 180 to 200 times a minute. In extreme cases the sick complain about dancing of the objects looked at, diminution of the visual faculty, dizziness, and headache. The rather painful dancing of the eye manifests itself in vibrations that run in vertical, horizontal, diagonal, circular, and elliptical directions. Especially those miners directly engaged in cutting the coal are afflicted with the disease, while the mine laborers are less subjected to it. The most serious cases can be cured, but it is generally necessary to quit working in the mines entirely. Ordinarily it takes two years to recover from the disease, figuring from the day the afflicted has discontinued working.

Of the numerous attempts at an explanation of the origin of this peculiar disease, Doctor Ohm considers that the trembling of the eyes is nothing but the sign of exhaustion of certain parts of the eye muscles. These are overtaxed through the poor light in the mines and through the raising of the eyes in connection with the work to be performed.

Answers to Examination Questions

Questions Selected From Those Asked at Examinations for Mine Inspector, Mine Foreman, and Fire Boss in Various States in 1914

Ques. 1.—The indicated horsepower of a pumping engine raising 1,000 gallons of water per minute 500 feet in a vertical shaft is 200 horsepower; what is the efficiency of the pump?

Ans.—Taking the weight of a gallon of water as 8.35 pounds, the horsepower actually exerted in raising the water is

$$\frac{GPM \times \text{Wt.} \times \text{Dist.}}{33{,}000} = \frac{1{,}000 \times 8.35 \times 500}{33{,}000} = 126.5 \text{ horsepower}$$

Since the indicator tests show that while the engine is developing 200 horsepower, the useful work exerted is but 126.5 horsepower, the efficiency of the pumping plant is $\frac{126.5}{200} = 63.25$ per cent.

Ques. 2.—Explain why it is economical in many cases in mining practice to employ compressed air or electricity in place of steam power.

Ans.—When power has to be transmitted from a generating plant on the surface to points of application underground, steam is not generally economical because of the loss in pressure through condensation in the pipes conveying it to the machines where it is to be used; whereas, the loss in pressure in the case of electric and compressed-air transmission is very small. Further, the exhaust from steam engines underground is a source of expense, in that the alternate wetting of the roof by day when the machines are in operation and its drying by night when they are idle, tends to rot it and produce falls which must be cleaned up. The effect upon the timbering of this wetting and drying is to cause it to rot, and adds to the mining expense through its renewal.

For haulage purposes, while in first cost a steam locomotive is cheaper than a compressed-air or electric locomotive because it does not require the building of a power plant, yet in the end it is not so cheap because it cannot be used for gathering, because it must be used on a special entry maintained for its use, and because it requires a much heavier air-current to dilute the gases given off by its burning fuel and this necessitates larger and more expensive ventilating machinery.

For the operation of coal cutting machines steam is not at all applicable, not only because of the effect of the exhaust upon the roof, but particularly because the high temperature to which the steam pipes would heat the air, especially in rooms where the air is apt to be sluggish, is exhausting upon the men.

Ques. 3.—What pressure and power would be required to produce and maintain an air volume of 150,000 cubic feet per minute, through an airway 8 ft. × 10 ft. and 3,000 feet long; and what would be the total power exerted by the fan engine if 70 per cent. of the power was expended on the air?

Ans.—The rubbing surface s is equal to $2 \times (8+10) \times 3{,}000 = 108{,}000$ square feet; $q = 150{,}000$ cubic feet per minute; and $a = 8 \times 10 = 80$ square feet.

$$p = \frac{k s q^2}{a^3} = \frac{.0000000217 \times 108{,}000 \times 150{,}000^2}{80^3} = 10.3 \text{ pounds}$$

The horsepower required to produce the circulation against the pressure just determined is found from the formula

$$\text{H.P.} = \frac{q p}{33{,}000} = \frac{150{,}000 \times 10.3}{33{,}000} = 49.85$$

Since but 70 per cent. of the power developed by the fan engine is exerted upon the air, the engine must have a total horsepower of $49.85 \div .70 = 71.20$.

Ques. 4.—If the mine was found free of gas on a previous examination, and on your next examination you found gas in one or more parts of the mine, to what cause or causes might this be attributed?

Ans.—Something would depend upon the length of time between the examinations. If they were the regular morning examinations made 24 hours apart, the trouble may be due to the escape of gas from old workings which accompanies a lowering of atmospheric pressure as recorded by a fall of the barometer, or the gas may have been forced out by heavy falls in the gob. The mining operations of the preceding day may have opened a feeder or blower of gas, may have encountered the drill hole of an abandoned and improperly cased oil or gas well, or may have entered an area of the seam which gives off gas more freely. The gas may also be due to a more sluggish air-current than usual, caused by slowing down the fan or by the more or less complete

(Continued on Page 514)

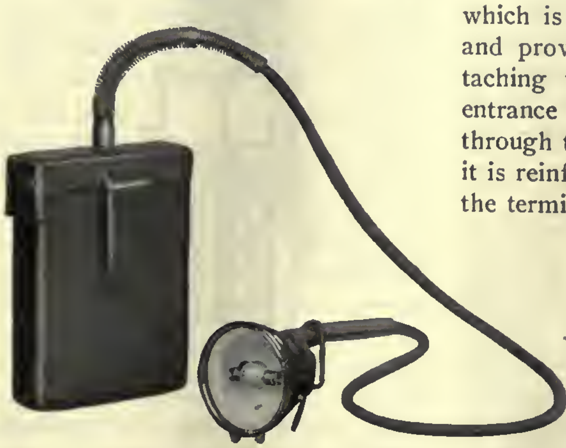
NEW MINING MACHINERY

Miners' Electric Lamp

The General Electric Co. is offering a new miners' electric lamp that is entirely safe to use, of very strong construction yet light in weight, simple in design, fool-proof, very efficient in operation and of ample guaranteed capacity. The outfit consists essentially of a lead-plate battery, carried on the belt; a ¾-candlepower Mazda lamp with a suitable reflector held in a steel shell, carried on the cap; and a strong, serviceable cable connecting the battery and the lamp.

Owing to the hazardous nature of work in gaseous mines, a demand has been growing for some time for a practical, portable electric lamp. That an electric lamp would be safe to use has been well recognized, because it could be made so that it would not ignite inflammable gases and would produce a uniform light regardless of atmospheric conditions. While the carbon filament lamp represented the best available electric illuminant, such a miners' lamp was not possible, because of the relative inefficiency of the lamp; for storage batteries of the required capacity could not be designed within permissible weight and dimension limits. The perfection of the efficient Mazda lamp in miniature sizes by the General Electric Co., and the development of small, efficient, light-weight storage batteries, has resulted in the design of the long-desired miners' electric lamp.

The prime feature of this lamp is that it has been made thoroughly safe to use. By adequate insulation of the entire circuit, placing all terminals and contacts inside of locked and sealed steel cases, and providing automatic means for extinguishing instantly the glow of filament, should breakage of the lamp bulb expose it to the air, this lamp, built of high-grade materials, has been made both safe and rugged. The outfit complete weighs 3¾ pounds, of which 3½ pounds are carried on the belt and 4 ounces on the cap. The battery is rated at 7.2 ampere hours. Normally it will light the lamp 12 hours per charge and can be relied on to furnish light at least 10¾ hours per charge at the end of 1 year's service. The ¾-candlepower Mazda lamp operates at 1.9 volts and the reflector distributes the light evenly through a solid angle of about 130 degrees.



Miners' Electric Lamp

The battery is non-spilling and the terminals are not subject to acid corrosion. The case is of medium hard rubber. Exide plates are used. The battery box measures 6¼ inches high by 5 inches wide by 2 inches thick, over all. It is made of drawn sheet steel, electrically welded, including the two side straps for the miner's belt. After welding, the box is lead plated and painted with acid-proof paint. The cover is drawn steel, hinged at one end and fitted with a substantial lock at the other end. The terminal contact block is riveted to the inside of the cover. Connection to the battery terminals is made by strong spring contacts, arranged to close the circuit when the cover is shut. The cable entrance bushing is watertight and clamps the cable firmly to prevent strain on the terminals.

The lamp bulb, reflector, and terminal contact block are encased in a light, strong, drawn steel shell, which is copper oxidized, enameled and provided with a hook for attaching to the miner's cap. The entrance bushing leads the cable through the back of the shell where it is reinforced by a steel plate. On the terminal contact block, which is waterproof and screwed to the protecting shell, are mounted suitable terminals for cable connections and the spring contacts which hold the lamp bulb. The contacts are nickel plated. The reflector is of drawn steel, white porcelain enameled. A rubber gasket between this and the glass renders the case waterproof. The glass is held by a phosphor bronze ring, with its ends looped and flattened to extend through slots in the case for a seal wire if desired.

The Mazda lamp bulb has its filament inserted and connected with a base contact in the usual manner, and at the tip of the bulb is a duplicate contact to which the filament is connected by a fine copper wire along the outside of the glass. The bulb is held at the focal point between the contact springs, which maintain it constantly under stress, so that, in case of a blow otherwise only sufficient to chip or partly break the bulb, it will be completely shattered by the springs and will drop clear of the contacts. Sufficient space is provided between the reflector and glass cover to keep broken lamp parts from short-circuiting the spring contacts. This prevents the possibility of ignition even if the cap lamp is seriously damaged amid explosive gases.

The cable consists of two, braided strand, rubber-covered conductors, each having a steel piano wire at the center. These are twisted together and then heavily rubber covered, making the cable strong, well insulated, and not liable to kink. The ends are protected from wear and damage by flexible steel armor.

To meet practice analogous to that of flame lamps, this electric lamp is designed to be supplied to miners from the lamp house. The outfits are to be assembled and locked with the lamps burning when delivered, and are to be returned to the lamp house in the same condition at the end of the shift. No care or attention whatever is required from the miners.

Direct current only should be used for charging. In some instances mercury arc rectified or motor-generator sets may be required to change alternating current into suitable direct current. Small sets adapted for this purpose can be supplied readily. Charging racks arranged for charging batteries conveniently in quantities are also offered.

Pressure Record

In England the law requires that a record shall be kept of the ventilating pressures at coal mines. The recording instrument designed to comply with this law was described in Vol. 34, page 300, of The Colliery Engineer.

The object of keeping a pressure record of a mine fan's action is to see that a uniform volume of air is kept in circulation. The anthracite mining laws require the mine foreman or his assistant to make such measurements near the face each week, and that the minimum quantity of air shall not be less than 200 cubic feet per minute for every person in the mine, and as much more as circumstances may require.

The companies comply with this law and even furnish more air than the law demands, but without a recorder there is no ready method of determining whether the proper volume of air is circulating, whether the airways are obstructed, or the air is being short circuited. By means of recorders, it is possible to keep checks on the air traveling each split and it may be registered in the superintendent's office at the surface. When a great variation in the quantity of air is registered on a chart it indicates that something is wrong in a certain air-course that needs investigation, if not quick remedial measures, to prevent accident.

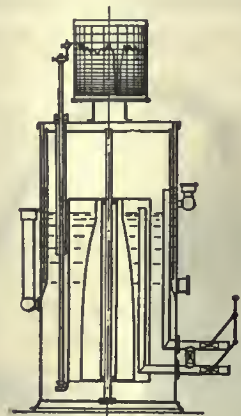


Fig. 2. "Hydro" Volume Meter

Using anemometers once weekly will not prevent accident if in the meantime there is a fall of ground, cars are left clogging cross-cuts, or doors are left open. To cope with such conditions hydropressure recorders are being manufactured by Herman Bacharach, of Pittsburg, Pa. The "Hydro" volume meter shown in cross-section, Fig. 2, consists of a cylindrical vessel partly filled with water. In this water is immersed a hollow bell, carrying a float. The interior of the vessel is closed to the atmosphere by a cylindrical cover which is water sealed. Communication between the fan upcast and the apparatus is established by two pipes, one leading into the space below and the other into the space above the movable bell. Each pipe is provided with a stop-cock; these cocks are connected together so that they operate simultaneously. By this means it is possible to admit the pressure to both sides of the bell at the same time. A three-way cock serves to connect the space above and below the bell with the atmosphere. The movement of the bell depends upon the pressure difference above and below the bell, and this movement is transmitted to the recording drum by a small rod, to which is attached a pen. The recording drum is slowly revolved, and every variation in the air pressure is transmitted from the upcast to the volume meter and then to the recording chart.

The engineer in charge of the fan can by looking at his chart tell at once if the engine or fan motor lacks power to keep the proper volume of air in circulation or whether there is something wrong with the ventilation in the mine. A portable velocity meter is also manufactured. This is taken into the mine and registers the velocity of the air-current by means of a pointer.

This saves all calculations, the volume of air passing in cubic feet per minute being indicated on the dial of the meter which is round like the dial on a groceryman's scale.

"Beaver" Cross-Bar Die Stock

This die stock differs from other die stocks in these features:

The dies are made in two sections.

1. The lower section does the rough work of starting on the pipe with teeth especially formed for this purpose, so it is always easy to start the thread. The die remains stationary during starting. After the upper section begins to cut, this lower die gradually withdraws from the pipe, until it no longer touches.

2. The upper die is a narrow receding die and constantly opens as the thread is cut, producing a perfect standard pipe thread on the well-known Beaver principle of continually cutting out less metal, the further you thread the easier the labor. These dies have the further advantage of following the partial threads cut by the first section, which still further reduces the labor and insures correct thread pitch without a leader screw.

The principle involved is as follows: A swiveled plug extends

down between the dies to the bottom of the upper section in starting. The pipe is started and threaded as usual; when the work of the lower stationary die is completed, the pipe end comes in contact with the swiveled plug, raising it as the second set of dies cut the thread. Raising the plug lifts the side posts, turns the engaged die cam, and gradually opens the dies at pipe taper until the thread is completed, when the dies are released—no backing off.

A universal guide centers all sizes from ¼ to 1¼ inches. The tool is regularly furnished with double-ended reversible dies ½ to 1¼ inches; extra ¼" × ⅜" dies can also be furnished and all sizes of dies either right or left hand.

It is made by the Borden Company, of Warren, Ohio, who have a new booklet on the subject.

TRADE NOTICES

Wendell Centrifugal Coal Drier.—A circular describing a new automatic centrifugal drier has recently been issued by the Link Belt Co. This drier is said to be rapid and effective in drying washed coal and other similar material. The entire performance is continuous and is accomplished by centrifugal force and gravity, no scraping or plowing devices being employed, thus eliminating wear and saving power. Particulars will be furnished from their nearest office.

Dissolution of Partnership.—Messrs. Ricketts and Banks announce that the copartnership heretofore existing between Pierre de P. Ricketts and John H. Banks terminated by mutual consent on March 1, 1915. After that date each will independently carry on the same line of business. The address of Doctor Ricketts will be 80 Maiden Lane, and that of Doctor Banks will be 61 Broadway, New York City.

Burning Low-Grade Fuel.—Among the signs of the increasing attention being paid to economy is the development of devices for burning low-grade fuel and slack. Some of these devices are poor, but many of them are good. One of the recent ones is made by the Imperial Combustion Co., of Chicago. Their confidence of success is shown by willingness to install their furnace without advance payment, taking their pay out of the saving effected.

Cotton Waste is a necessity to operators of machinery and is often not bought or used to the best advantage. For certain purposes only the best quality must be used, while for other work a cheaper grade answers every purpose. In the past it has been difficult to determine the exact kind needed, or to be sure of being able to duplicate the order after a suitable quality has been found. To avoid these difficulties the Royal Mfg. Co., of Rahway, N. J., have standardized the grades of cotton waste with the trademark "Royal" and have prepared folder samples showing 12 different grades. By the use of these samples, the quality needed can be readily determined, and orders specifying name or number will always bring the desired material. Other features guaranteed by the manufacturers are: Exact quality all the time; tare of packages not over 6 per cent. of their weight; bales actual weight—a 100-pound bale is 100 pounds—careful packing with good burlap and steel bands, the latter bearing the mark "Royal" stamped upon them, all of which are guaranteed.

The Roberts and Schaefer Co., of Chicago, have contracted for the building of Marcus patent coal tipples for the Harty Coal Co., Mullens, W. Va.; Moffat Coal Co., Oak Creek, Colo.; Henderson Coal Co., Hendersonville, Pa.; and the Sunnyside Coal Mining Co., Denver, Colo. These plants are modern installations and will be equipped with thorough screening and picking facilities. They will also build for the Ayrshire Coal Co., of Oakland City, Ind., a 500-ton coal washing plant, at their No. 7 mine near Ayrshire, Indiana. Approximate cost for this will be $30,000.

Retarding Conveyer.—The P. C. & Y. Coal Co., which is controlled by Mr. B. S. Hamil, general manager of the Meadow Lands Coal Co., at Pittsburg, has contracted with the Fairmont Mining Machine Co. for a cable retarding conveyer about 600 feet long, and tipple equipment, to be installed at Thornburg, Pa., a suburb of Pittsburg.

The Davis Colliery Co. and Junior Mercantile Co. moved into their new office and store building at Bower, W. Va., on January 1, 1915. This building replaces the one destroyed by fire, March 16, 1914, and is of absolute fireproof construction: walls of brick; floors, roof, and stairways of concrete; and partitions of gypsum blocks. The basement and first floor are occupied by the Junior Mercantile Co., and the upper floor by the Davis Colliery Co. as offices, drafting room, and bed rooms. The arrangements and conveniences embody the latest thought in buildings of this kind and no doubt it is the finest building for its purpose in the state. The total cost of construction was about $30,000.

Catalogs Received

Consolidated Engine-Stop Co., 130-32-34 East 12th Street, New York, N. Y. The Protection of a Monarch, 39 pages.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin E-35, Universal Electric Drills, 7 pages; Circular, No. 11 Boyer Riveting Hammer.

Imperial Brass Mfg. Co., Harrison Street and Racine Avenue, Chicago, Ill. Imperial Oxy-Acetylene Apparatus, Catalog No. 111, 19 pages.

Bristol Co., Waterbury, Conn. Bulletin 192, Bristol's Long-Distance Electric Transmitting and Recording System, 8 pages.

John A. Roebling's Sons Co., Trenton, N. J. Circular "450 Tons."

American Locomotive Co., New York, N. Y. Pamphlet No. 10040,

Standard Light Locomotives, 24 pages.

Weinman Pump Mfg. Co., Columbus, Ohio. Steam and Power Pumping Machinery, General Catalog.

Cambria Steel Co., Johnstown, Pa. Slick Steel Mine Ties, 41 pages.

Improved Combustion Co., 445 Peoples Gas Bldg., Chicago, Ill. The Nicholson Furnace, for Steam Boiler Plants, 11 pages.

Link-Belt Co., Chicago, Ill. Bulletin No. 212, The Wendell Centrifugal Coal Drier, 4 pages.

Roberts & Schaefer Co., Chicago, Ill. Locomotive Coaling Plants, 8 pages.

Marion Steam Shovel Co., Marion, Ohio. Digging and Mixing Clay, One Operation, 29 pages.

Trussed Concrete Steel Co., Youngstown, Ohio. Kahn Pressed Steel Building Construction, 20 pages.

Harris Brothers Co., 35th and Iron Streets, Chicago, Ill. Machinery and Supplies, Special Catalog No. 214, 96 pages.

George T. Ladd Co., Pittsburg, Pa. Bulletin No. 16, Milne Water-Tube Boiler, 4 pages.

General Electric Co., Schenectady, N. Y. Fabroil Gears, Bulletin No. 48702, 25 pages.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Repair Part Price List, No. 1906, Christensen Air Compressors, 7 pages.

Cochrane Multiport Valves, a booklet of 72 pages just issued by the Harrison Safety Boiler Works, Philadelphia, describes multiport valves introduced by that concern for back-pressure relief and vacuum service, flow service in connection with mixed-flow turbine, and check-valve service with bleeder or extraction turbines. The essential idea of the multiport valve is the use of a number of small disks instead of one large disk in order to secure greater safety, quietness, lightness of moving parts, and tightness.

Terry Steam Turbine Co., Hartford, Conn. Bulletin 19. Terry Turbines for Pump Drives, 64 pages.

BOOK REVIEW

A review of the latest books on Mining and related subjects

West Virginia Geological Survey. Detailed Report on Logan and Mingo Counties, issued under date of January 15, 1915, containing 776 pages +XXI of introductory matter, and illustrated with 15 half-tone plates and 23 figures or zinc etchings in the text; also a case of two maps covering the topography and geology of the entire area of both counties in one sheet. The soil map and report soon to be published will be sent gratis later to all who receive this volume. In addition to the detailed description and revision of all the rich coal beds and other geologic formations exposed in these counties, the geologic map gives the structure contours and outcrops of the celebrated No. 2 Gas Coal, as also that of several other valuable coal beds, along with many new sections, analyses, etc., etc. Price, with case of maps, delivery charges paid by the Survey, $2, but for combination price with other publications, see general circular of publications. Extra copies of geologic map, $1 each, and of the topographic map, 50 cents each. West Virginia Geological Survey, P. O. Box 848, Morgantown, W. Va.

The Electrical Pocket Book and Diary for 1915, published by the *Mechanical World*, Manchester, England, has been revised and brought up to date. The price also has been enlarged to 50 cents. New sections are given on Electric Circuits and Switching; Synchronizing and Phasing Out; Alternating Current Generators and Motor Troubles, etc. The section on Electricity on Shipboard has been rewritten and extended considerably; while substantial additions have been made to the sections on Electricity in Coal Mines, Motor Starters, etc., The matter on Dynamo and Motor Defects published formerly has been revised, also on Electric Lamps and on Electric Lighting. The Norman, Remington Co., 308 North Charles Street, Baltimore, Md., are the distributors.

Large Class of First-Aid Workers

The largest class of mine-rescue and first-aid workers yet trained in the West Virginia coal fields has recently completed a successful course at Gary, in McDowell County, and 86 miners have been thoroughly trained for the work at this place by the crew of the United States Mine Rescue car No. 8, which has been in the Pocahontas field for the past 2 months. In addition to this number, 6 young men from the Gary High School were also given complete first-aid training.

A large number of classes have been trained by the crew of this car in the Pocahontas field, and at each place enthusiasm and interest have been displayed by both mine officials and employes.

What is Anthracite?

The usual calculations as to the price of anthracite and resultant profits to the operators ignore the fact that a ton of anthracite at New York harbor costs from $1.80 to $5.60, and on the lower-priced tons of coal there is no profit at all.

There are nine different standard sizes of anthracite, called lump, steamboat, broken, egg, stove, chestnut, pea, buckwheat, and rice or buckwheat No. 2, and some of the operators produce still further smaller sizes. A ton of each size of coal brings a different price. In order to get the average price the proportion of each size produced should be taken into consideration.

The sizes below pea coal known as "steam sizes" are sold at a loss in competition with bituminous or soft coal. The only reason why they are handled at all is because it is impossible to mine anthracite and break it into the other sizes required without producing these unprofitable sizes.

French Electric Mine Hoist

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provided with auxiliary poles and developing normally 600 kilowatts at 500 volts. A special change-over switch allows the carrying of the current of either generator chosen, to the winding-motor circuit. In order to feed the motor under variable pressure by this method, the excitation of the dynamos is taken from the 500-volt busbars of the central station and passes through a rheostat analogous to that of the generator of the converter set. This rheostat is operated by the same lever and a very simple arrangement allows the connection of either of the rheostats to the operating lever.

This installation has given some remarkable results; the running is flexible and regular, the operating movements are rapid and certain, and all the retardations and stops can normally be obtained by acting on the single operating lever. The time of hoisting varies from 28 to 32 seconds, and the times of the loading and unloading operations vary between 8 and 12 seconds, so that the mean value of 40 seconds corresponds very well to the requirements originally planned. It has been possible to realize in normal service 95 hoists per hour, and this suffices to prove the extreme precision of running. Operation with the generating set at the central station has given excellent results and the whole plant is an illustration of first-class design and workmanship.

Kentucky Mining Institute

The Kentucky Mining Institute has tentatively selected May 14 and 15 for the spring meeting which is to be held at Pineville, Ky.

During the past year the United States Steel Corporation installed about its steel and coal operations 1,193 wash basins, 210 showers, 15,471 lockers, and two additional swimming pools, at a total cost of $141,000. The corporation spent $564,977 in sanitation work and is maintaining 101 playgrounds.

The Forest Service and the Prospector

By Leroy A. Palmer

So much has been said and written about the relation of the Forest Service of the United States Department of Agriculture to the mining industry, and so many misconceptions have been formed, that a few facts on the subject should be of interest to those actually engaged in mining.

In the first place, let it be understood that the fact that land is included in a National Forest is no bar to mining or prospecting thereon. Paragraph 114 of the regulations under the United States Mining Laws published by the General Land Office, states:

"The act of June 4, 1897, provides that 'any mineral lands in any forest reservation which have been or which may be shown to be such, and subject to entry under the existing mining laws of the Uited States and the rules and regulations applying thereto, shall continue to be subject to such location and entry notwithstanding the reservation."

In this connection it is of interest to note that an investigation by the Forest Service showed that during 1912 there were 2,560 prospectors within the National Forests of Colorado, as compared with 1,475 on unreserved public lands immediately adjacent.

The relation of the Forest Service toward the possession of or acquisition of title to mining claims is confined to requiring that compliance shall be had with the mining laws of the United States, and is never asserted unless and until application is made to patent, except where improper use is made of a claim which actively interferes with the administration of the forest. The Forest Service has no authority to supplement the Federal laws with regulations of its own making, as can be done by states or mining districts, such as to require that a discovery shaft be sunk on the claim

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The Forest Service and the Prospector

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or that the discovery of mineral shall be made in the discovery shaft, as provided by the Colorado statutes, nor can it issue or refuse patent, this being exclusively a function of the Secretary of the Interior. When the owner of a mining claim desires a patent, the procedure is as follows:

The Surveyor General notifies the Forest Service when order for mineral survey is issued and if possible the ranger accompanies the surveyor and makes his examination coincident with the survey, in order to obviate possibility of delay and to make sure of the location of claim lines and extent of improvements. If unable to be present when the survey is made, he makes his examination as soon as possible after application to patent is filed, and, except in occasional instances, this report is submitted to the General Land Office before the expiration of the 60-day period of publication, so that the examination by the Forest Service does not delay the issuance of patent, except in case the required expenditure has not been made upon the development work.

Section 2320 of the Revised Statutes states that "no location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located." But the ranger does not inquire into whether a discovery has been made. If the claim is in a recognized mineral locality, if the requisite expenditure of $500 has been made, and if the indications are that it is being held in good faith and not as a subterfuge to acquire ground for other than mining purposes, he will make a favorable report. In most cases, compliance with the second condition carries the third with it, and in this connection it might be well to quote from the National Forest Manual:

"It is not the purpose or the intent of the department to initiate contests against claimants who have entered lands in the National Forests in good faith to secure a home or for other purposes recognized by law, and in such cases no contest should be initiated on slight, technical non-compliance with the law."

An opinion, quite general, seems to prevail that contests against supposedly invalid claims are initiated on the report of the ranger, who—it is true—sometimes has little or no knowledge of mining. This is incorrect. On receipt of a report from a ranger showing the noncompliance with the above conditions, the mineral examiner is detailed to the case. The mineral examiner is a man who must have had actual mining experience. He qualifies for his position by submitting to the Civil Service Commission a detailed account of his experience, with references to five previous employers and signed statements by two persons personally able to testify as to his fitness for the position, which application, if satisfactory, admits him to a competitive examination which consists chiefly of questions on geology and mineralogy.

The mineral examiner makes an exhaustive investigation of the claim, measuring and estimating the work, and also considering the question of character and extent of discovery, and if it develops that no discovery has been made, as well as the claim being deficient in other respects, the facts are reported to the General Land Office. If the Commissioner considers the facts sufficient to justify cancellation of the application for patent, the claimant is informed of the charges against the claim, and given an opportunity to present his evidence at a hearing.

At the hearing both sides are represented by counsel and introduce witnesses as in a suit before a court of law. The evidence is submitted to the Register and Receiver of the Land Office of the district in which the claim is situated and they render a decision for or against issuance of patent, subject to approval by the Commissioner of the General Land Office. Appeal from this decision may be taken to the Secretary of the Interior.

Forest Service Free Use Policy.—A prospector engaged in working his claim is entitled to such timber found thereon as may be necessary for its development, which includes timber for buildings, fuel, etc., as well as the actual support of excavations, and need make no application therefor. If there is no timber on the claim, he sends word to the ranger who calls on him and issues a free use permit for any amount necessary, up to $20 stumpage value. In case of an emergency, he can take such timber as he may need immediately, and notify the ranger at his first opportunity.

Probably a fair average of the prices computed for free uses in the Second District, which includes Colorado, Wyoming, South Dakota, Minnesota, and Michigan, would be $2 per thousand feet board measure for green saw timber, $1.25 per thousand linear feet for lagging, and 25 cents per cord for firewood. If a prospector were living on his claim and working it the year round, twenty cords of firewood, $5 worth, should be ample for his needs. This would leave him $15 worth of timber for his workings. A post 8 inches in diameter and 8 feet long is scaled at 10 board feet. Such a timber, cut to say 6½ feet in length, has a safe working load (Western yellow pine) of 46 tons for well-seasoned timber, and half that amount for good timber. A post 10 inches in diameter and 12 feet long, sufficient for two caps, and some over, scales as 30 feet, so that two drift sets would scale 70 board feet, 14 cents worth of timber, a cost of 1¾ cents per foot of tunnel, if the sets are placed on 4-foot centers. To lay a 5′×7′ drift on top and sides with 6-inch split lagging would require 19 feet of lagging per foot of drift, or 2⅜ cents per foot, so that the total cost at which the timber for a 5′×7′ drift would be figured would be 4⅛ cents per foot, so that the $15 mentioned, after allowing for firewood, would furnish timber for 364 feet of drift and

leave plenty of scraps for blocking, fuel, and other uses to which they could be put, all of which, under free use permit, he obtains for nothing. Of course a shaft would require more timber per foot, but less work is accomplished in the same time. Very few prospectors require that amount of timber in a year, but a prospector may cut as much timber as he wishes from his claims without permit if the use to which it is put tends to develop the claim from which it is cut; and in cases of unusual need, the Forest Supervisor may extend the free use permit to an amount not exceeding $100.

Much more detail could be entered into along these lines, but I trust that the above facts may correct some of the prevailing misconceptions of the attitude of the Forest Service toward the mining industry, and to show that it is the desire of the Service to promote and not retard the development of our mineral lands.

Examination Questions

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short-circuiting of the air current outbye the place where the gas was found. The short-circuiting may be caused by leaving some important door open, by failure to build brattices as fast as the breakthroughs are driven, or by failing to replace a brattice accidentally destroyed. A heavy fall in the return air-course or the unauthorized opening of a regulator will seriously interfere with the ventilation and may cause an increase in the amount of gas.

QUES. 5.—If a breast having a pitch of 35 degrees is shown on a map as being within 130 feet of an upper level, what would be the actual thickness of the dividing pillar?

ANS.—Distances, as shown on a map, are all horizontal ones obtained by multiplying the distance as measured along the pitch by the cosine of the angle of dip or elevation. Consequently, to find the distance as measured on the pitch, when the horizontal distance (map distance) and angle of slope are given, the foregoing process is reversed. That is, the map distance (horizontal) divided by the cosine of the angle of pitch is equal to the pitch distance as measured in the mine. In the example,

$$\text{Pitch Distance} = \frac{\text{Map Dist.}}{\text{Cos angle of pitch}}$$

$$= \frac{130}{\cos 35^\circ} = \frac{130}{.81915} = 158.70 \text{ feet}$$

QUES. 6.—Why do the laws of this state prohibit the use of fine coal or slack for tamping shot holes?

ANS.—Because, if a poorly placed hole results in a blown-out shot, the powder may ignite the slack used for tamping and this, in turn, may ignite the coal dust in the room and be the means of starting a dust explosion that will spread over the entire mine. Even if a blown-out shot does not take place, the throwing of such a large amount of burning slack into the air, particularly if the mine is dusty or is slightly gaseous, may cause a dust or gas explosion.

Further, the gases given off by all powders, and particularly black powder, contain a considerable amount of carbon monoxide, which is very poisonous. It has been found that where slack is used for tamping, the gases contain three to five times as much CO, as when it is not. Thus, a black powder, the gases from which contained about 6 per cent. CO_2 when exploded in the laboratory, contained 18 to 30 per cent. CO when exploded with slack for tamping. This CO results from the imperfect burning of the carbon in the slack, or from the gases distilled from the coal by the heat of the exploding powder. By imperfect burning is meant a burning without sufficient oxygen to form carbon dioxide. As less than .05 per cent. of CO in the air is dangerous, and 1 per cent. will cause death in a few minutes, any action increasing the amount of this gas in the air should be prohibited.

Finally, the products of combustion of all powders contain a greater or less proportion of gases which are themselves explosive. The amount of these explosive gases is greatly increased where slack is used for tamping, as explained in the preceding paragraph. While there is always danger of the miner lighting these gases by returning to the face too soon after firing a shot, this danger is greatly increased where slack tamping is used.

Ques. 7.—The diameter of the piston of an engine is 10 inches and the length of stroke is 15 inches; the engine makes 250 revolutions per minute with a mean effective pressure of 40 pounds per square inch; what is the horsepower of the engine?

Ans.—The horsepower may be found by substituting in the formula

$$\text{H. P.} = \frac{PLAN}{33{,}000}$$

$$= \frac{40 \times 1.25 \times (.7854 \times 10^2) \times (250 \times 2)}{33{,}000}$$

$$= 59.5$$

In this formula, P = mean effective pressure in pounds per square inch = 40; L = length of stroke in feet = 1.25 feet = 15 inches; A = area of cylinder in square inches = $.7854 \times 10^2$; N = number of strokes per minute = twice the number of revolutions per minute = 250×2.

Ques. 8.—Why do the laws of this state require the entries to be watered and the employment of shot firers; do you think this is sufficient?

Ans.—The law requires the entries to be watered because it has been proved that when the coal dust on the roof, ribs, and floor is wet, the propagation or spreading of an explosion by means of dust is not generally possible. While the amount of water required for this purpose will vary with the fineness and character of the coal, the entries are required to be watered often enough to keep the dust so saturated that it will remain in balls when gathered up and compressed in the hands.

The law requires shot firers to examine and inspect the holes and to reject any such as are improperly tamped or placed and are for any reason likely to cause a blown-out or windy shot; the shots are to be fired by electricity after the miners have left the mine. The object of this law is to reduce the number of accidents resulting from blown-out shots and, if an explosion does take place, to limit the number of men exposed to the danger.

The object of all laws such as these is to reduce the danger and effects of dust explosions, either by reducing the amount of dust made in mining, by rendering harmless such dust as is unavoidably made, and by reducing the number of men exposed to accident. I think the law is defective in that it takes no steps to reduce the amount of dust made, which may be accomplished by prohibiting solid shooting and by requiring that the seam be undercut to a depth at least 6 inches more than the depth of the deepest shot hole and by limiting the powder charge to 1½ pounds of permissible powder. The undercutting before blasting and the small charge of short-flame (permissible) powder will also tend to prevent blown-out shots which might ignite the dust. Further, the dust made by coal mining machines should be loaded up and carried from the mine, as should be all road and ditch cleanings. Tight cars should be used, and road cleanings should not be used as filling between brattice walls. The working face and the room or entry for 60 to 80 feet back from it should be thoroughly watered down before a shot is fired.

I think the law in relation to shot firing could be improved by requiring the shot firers to charge and tamp the holes instead of leaving this to the miner. As matters now stand, while they have the right to refuse to fire a hole they consider unsafe, it is not possible to tell if the hole is the right depth, is charged with the right amount of explosive, and is properly tamped, unless the shot firer himself does all the work. It is not just to throw the responsibility of accepting or rejecting a hole upon the shot firer when it is impossible for him to know how this work has been done.

Ques. 9.—An engine showed that it developed 60 horsepower while pulling a load of 3 tons up a shaft 148.5 feet deep in 30 seconds; what is the efficiency of the engine?

Ans.—One horsepower will do $30 \times 550 = 16{,}500$ foot-pounds of work in 30 seconds. The work performed by the engine is equal to $3 \times 2{,}000 \times 148.5 = 891{,}000$ foot-pounds of work in the same length of time. Hence, the engine is actually exerting $891{,}000 \div 16{,}500 = 54$ horsepower. Expressed as a formula

$$\text{H. P.} = \frac{3 \times 2{,}000 \times 148.5}{30 \times 550} = 54$$

Since the engine develops 60 horsepower and does but 54 horsepower of work, its efficiency is $\frac{54}{60} \times 100 = 90$ per cent.

Sixty is the average horsepower of the engine, which will exert very much more than this while getting up to full speed; that is, while accelerating the load, and will exert considerably less than this at the end of the run where the rope on the empty

side is all acting in favor of the load and where it may be necessary to apply the brakes to bring the cage to rest.

Ques. 10.—How would you examine a hoisting rope, and what indications would lead you to think that the rope was defective?

Ans.—A hoisting rope is commonly examined by running it through the hand while the engine is turned as slowly as possible. This will detect any broken and projecting wires and the eye may note others which are cracked. Any part of the rope indicating that it has been kinked should receive particular attention, as should the socket. Owing to the possibility of corrosion at that point from acid mine water, it is the custom at some mines every few months to cut off a portion of the lower end of the rope and to resocket it. Internal corrosion cannot generally be detected by ordinary means, and danger of breakage from this source can only be guarded against by changing the rope for a new one either at the end of a fixed period of time or after it has hoisted a certain number of tons of coal. The latter is the practice of most of the larger companies.

Ques. 11.—How far must a weight of 75.375 pounds be placed from the fulcrum when the safety valve has a diameter of 3 inches and its stem is placed 4 inches from the fulcrum. The valve is to blow off at 75 pounds pressure, and the weight of the lever and valve are to be disregarded.

Ans.—The total pressure of the valve when it blows off, will be equal to the area of the valve multiplied by the steam pressure in pounds per square inch or to $(.7854 \times 3^2) \times 75 = 530.145$ pounds. Since the forces or weights are proportional to their distances from the fulcrum, it follows (placing x equal to the unknown distance of the weight) that $x \times 75.375 = 4 \times 530.145$. Solving for x, x = distance of weight from fulcrum = 28.13 inches.

Ques. 12.—What, in your opinion, is the best kind of boiler for use at a coal mine, and what are the usual appliances and fittings furnished with it?

Ans.—The best type of boiler is none too good for use at a coal mine. It was formerly supposed that practically any cylindrical iron tank that would stand the low pressures then in use would do for a boiler, whether it was economical or extravagant in the use of fuel, because it was held that at a mine, "the coal costs nothing." It is now realized that the coal at the mine must be charged to the account of steam raising or power house, at least at its actual cost, and many companies charge it up at the price it would bring in the open market. It is apparent, then, that there is as much room for economy in saving coal at the boilers as in saving timber, rails, or any other kind of supplies. For this reason, the larger modern mine power plants are equipped with the very best water-tube boilers arranged to burn the smaller and lower priced sizes of coal, and many of them are equipped with automatic stokers to save in the labor costs of firing. A step further is often taken at plants making coke, where the otherwise wasted gases from the ovens are conducted through firebrick flues and used to raise steam in boilers, thus entirely dispensing with the use of coal in the power generating plant.

Boilers are provided with a safety valve to prevent a greater pressure in the boiler than that for which it was designed; with a steam gauge, consisting of an indicator with a hand or pointer the end of which shows on a circular dial the pressure of the steam in the boiler; with a water gauge to show the level of the water in the boiler; with gauge cocks to actually test the height of the water in the boiler, one being placed at the proper water level and one about 2 to 3 inches above and another the same distance below the first; with a feed-pump or injector to force water into the boiler; with a feedwater heater to heat the feedwater; with a steam separator to dry the steam before it passes to the engine cylinders; with a mud-drum, usually placed at the rear and below the boiler to collect the sediment deposited by the water in the boiler; with a blow-off valve at the bottom and rear of the boiler to blow off and clean the boiler; with a steam drum to hold the steam before it passes to the engines; and with various hand and man holes to afford access to the interior of the boiler for inspection and repair.

Ques. 13.—How can the bad effects of scaling in a steam boiler be prevented?

Ans.—The proper method of preventing scale is generally the object of investigation by competent chemists or mechanical engineers, and the one selected will, in general, depend upon whether the scale forming impurities are suspended mechanically in the water or are in solution. Among the precautions and remedies are: Filtering out suspended impurities before the water enters the boiler; frequent blowing off of the surface of the water in cylindrical boilers to remove scum floating on it, and blowing off of the entire boiler at such regular intervals as experience has proven to be necessary; maintaining a thorough circulation in the boiler; heating the feedwater; chemical treatment of the feedwater before it enters the boiler; chemical treatment of the water in the boiler.

Miners' Poor Lights

William Seddon in his early recollections of the Western Pennsylvania Mining Institute, now the Coal Mining Institute of America, states that John Porter in 1887 read a paper on lighting coal mines by electricity. This paper showed how many accidents could be avoided in mines, provided sufficient light was given miners, particularly on haulage and traveling roads. Mr. Seddon remarked that slow progress had been made in furnishing miners with suitable lamps to enable them to discover crevices in top rock. He attributes a large number of the injuries and fatalities due to rock falls to poor lights.

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Mining in the Broad Top Coal Field

The Geology of the Region, and the Methods of Mining That Are Necessitated by the Irregular Formations

By William Z. Price

PROBABLY no coal field in the United States has been so little mentioned in technical and coal trade journals as the isolated region in the southern end of Huntingdon County, Pa. It extends south across the line 7 miles into Bedford County, and approximately 3,000 acres lie in Fulton County, to the southeast. Geographically it is, then, between the anthracite and the bituminous districts. Similarly, the Broad Top coal is intermediate in character between anthracite and bituminous and may be classed as semibituminous.

The history of the field is uncertain. Some say that certain Englishmen, who were Tories and disinclined to fight with the Colonists in the Revolutionary War, fled westward and took up their abodes in the Broad Top region. If this is true it is highly probable that they were the first to mine the coal.

The commercial opening of the country began with the completion of the Huntingdon & Broad Top Railroad from Huntingdon to Hopewell in 1856 and the branch from Saxton to Broad Top City about the same time. It was not until 1874 that the narrow-gauge road along the eastern edge of the field was built. This road is operated by the East Broad Top Railroad and Coal Co.

It was while Broad Top City was a summer resort in the 60's that the Roberts and Woods, of Philadelphia, and the Markles and Pardees, of Hazleton, after visiting the district began operations near what are now Robertsdale and Woodvale. One of their engines is now in operation at the Woodvale shaft. It is a 26 x 48 second-motion hoisting engine and has two 14-foot drums.

Fig. 1. Plane at Ladysmith Mine

The Broad Top coal field lies in the tableland known as Broad Top Mountain. On the western side is the Huntingdon & Broad Top Mountain Railroad which connects with the Pennsylvania Railroad on the south at Mt. Dallas and with the same railroad at Huntingdon to the north. Along the eastern edge is the East Broad Top Railroad which extends from Woodvale on the south to Mt. Union on the north, where the coal is reloaded into standard-gauge cars of the Pennsylvania Railroad.

The seams mined are the Kelly, Barnett, and Fulton. At some places the Twin seam is seen just above the Barnett, but this is so small that it is of no commercial importance. It has only been worked in the eastern end of the field. The Fulton is found close above the Pottsville sandstone, the Barnett about 40 feet above the Fulton, and the Kelly from 60 to 90 feet above the Barnett. These distances are greatly variable as the intense folding in the region brings them much closer together in some cases.

Fig. 2. Map of Broad Top Coal Field

The Kelly seam has been eroded entirely from the eastern side of the field, but along Six-Mile Run, Sandy Run, and the western side in general, it is the principal seam that is now being mined. In some few instances the Barnett is being worked, but not to any great extent.

The coal is friable and has numerous fracture planes. Owing to the extreme folding, it is thoroughly slickensided along its fracture lines. In some places the coal is so crushed that it is recovered as slack. However, the coal throughout the field is sold as mine run. Owing to the uneven and ever-changing floor, together with the variable middle rock, the use of machines is impossible and mining is done entirely by hand.

With the Pottsville formation directly beneath, and below that the Mauch Chunk red shale, it is manifest that the coal is a part of the anthracite measures. Northeastward the formation is continuous with the basin that holds the northern anthracite region along the Susquehanna River. Considering that the hardness of the coal is much less than that of anthracite, the question is often asked "Why is not this coal as hard as the anthracite, if it is of the same measures and has been subjected to numerous convulsions and disturbances?" The question is rather difficult when the field is but casually reviewed, but upon closer examination it is noticed that the measures in the Broad Top region are only about 1,200 feet in thickness while those of the anthracite region are over 3,000 feet thick. It is plain, therefore, that increased weight and heat combined with lateral or upward pressure must necessarily have metamorphosed the coal to a greater extent.

The formation as a whole dips westward. The Fulton seam in Wray's Hill, a mile east of Robertsdale, is 2,200 feet above sea level, while at Riddlesburg, 9 miles to the west, the Kelly (the top seam) is being mined at 800 feet above tide. Between these two points are 13 distinct basins, and each of these is at some place made up of numerous smaller basins of varying depth and extent. In the working of the coal a number of years ago, the mining was done exclusively on the anticlinals chiefly because it was easier and cheaper mining, and also because there were no means of hauling heavily loaded cars out of the dips at that time.

At Robertsdale, the Rockhill Iron and Coal Co. has two operations, both slopes in the Fulton seam. At Woodvale, a mile to the south, the same company has a shaft 200 feet deep to the Fulton seam. Only two seams are minable at Robertsdale, the Barnett and the Fulton, and these seams lie in a peculiar manner. The interval is 45 feet at Robertsdale, a mile to the south the interval increases to 90 feet, and at a point a mile still farther south the seams come together and show a total thickness of 12 feet. This was determined by diamond-drill holes. A section of the Barnett and Twin shows 5 feet of coal with a parting of sand rock and shale in the middle of the seam, varying from 1 foot to 15 feet in thickness. The Fulton seam is from 4½ to 8 feet in thickness with a sandstone parting varying from 2 inches to 5 feet in thickness. In a number of instances the parting in the coal at the entry is seen to be but a few inches. This naturally seems to be adaptable for

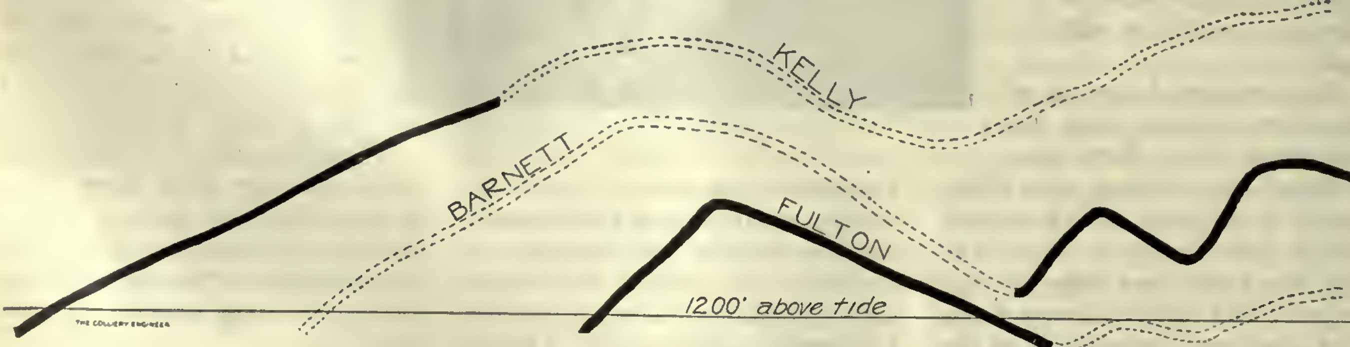


Fig. 3. Section of Broad Top Seams at Six-Mile Run. Vertical Scale Is 5 Times the Horizontal

Fig. 4. Tipple at Six-Mile Run

room work. However, in many such cases the parting thickens to 4 or 5 feet before the room has gone 250 feet. Conditions like this where yardage is continually being paid to the miner, increase the cost of mining considerably.

In some cases the coal takes a sharp dip and appears to be "pinching out." In one instance this was thought to be the extremity of the seam at that point and work was abandoned. Another time the same condition was encountered and by driving ahead it was found that the seam quickly resumed its horizontal position at its customary thickness. This is very similar to anthracite conditions, but the extreme folding and overlapping of the anthracite district is not found in the Broad Top region. Rooms cannot be calculated to go on a certain course for their full distance and a contour of the mine roof would be misleading.

In mining the Barnett and Twin seams, some years ago, the coal in the bottom bench was first mined out, then the sandstone parting was blown down along the entire room distance, a track was laid on top of this rock, and the upper bench or Twin seam was mined out. This eliminated the handling of the parting but was not economical because the pillar on the bottom bench was lost and squeezes were always liable to result. This method was called "rangering." When the rock was too thick for this work, holes were driven up to the Twin and the coal after being mined was dropped through to a car below.

The Barnett seam is overlaid by a hard compact sandstone whose strength can be appreciated from the fact that some of the rooms and entries were driven at enormous width and the roof is still as firm as ever after many years, though there is not a stick of timber supporting it. The bottom of the seam is a flinty fireclay. This is reddish in color and in some places contains a high percentage of iron which lowers its refractory nature, thus making some of it unfit for the furnaces. In the Fulton seam a similar bottom is found and a softer roof which in some cases requires extensive timbering.

The coal has the following average analysis: Volatile matter, 16; fixed carbon, 76.50; ash, 7.50; sulphur, 1 to 1½ per cent.; B. T. U., 14,550.

The Robertsdale slope, at Robertsdale, is in the Fulton seam, and throughout its 8,000 feet of length is a series of rises and dips. This necessitates the tail-rope haulage. It is necessary to have a competent hoisting engineer at the throttle owing to numerous changes of grade that cause his work to alternate between holding back on the tail-rope and the speeding up of the head-rope.

At the slope bottom is the turnout or side track, to which point coal from the main sections of the mine is hauled. This is mostly accomplished by means of a Lidgerwood electric hoist situated near the far end of the turnout. The empty cars are lowered down the main heading and then branched off into the room entries to the right and left. A tail-rope is used. This means an individual tail-rope for each entry. The hoist has a capacity of fifteen 2-ton cars per trip, on a 15-per-cent. grade.

In another section of the mine, the empty trip with the haulage rope attached is hauled to another side track by the use of an air hoist. The loaded trip is then hauled out with the rope from the air hoist acting as a tail-rope. This auxiliary

hoist is necessary on account of the heavy strain to which the main tail-rope would be subjected. This is due to the varying grades and the difficulty in finding a rope strong

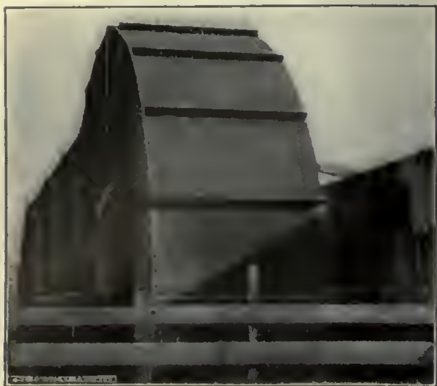


Fig. 5. Fan at Woodvale Air Shaft

enough to do this work and at the same time flexible enough to go around the small sheave wheels.

Numerous Pneumelectric room hoists are used. The use of such engines is imperative owing to the variable pitch of the coal. These room hoists have a single drum which is engaged with the motor driving gears through a positive clutch. By simply disengaging the clutch, the drum runs idly on the shaft under the control of the brake. The rope drum is made of cast iron with space for winding 700 feet of ⅜-inch wire rope. The attachment used for fastening the rope to the drum is simple. It consists of a bell-shaped hole in one of the drum flanges and a plate with cap screws to firmly hold the end of the rope.

The gearing is all spur, double reduction. Meshing into the main gears, which is part of the drum, is a semi-steel pinion with its teeth cut out of solid blank.

These hoists are invaluable owing to the rapid wearing out of mules. In numerous places, it requires three mules to pull one loaded car. This not only shows the roadways to be on such a grade that mules are not powerful enough, but that it is decidedly an expensive proposition.

At the last inventory of the Rockhill Iron and Coal Co. it was found that there are over 15 miles of rope in use at their operations, which consist of a shaft and two slopes, one of which is being operated on a small scale.

By means of the rope haulage system on the slopes and with 12 underground hoists, such as have been described, the daily production from the three openings approximates 1,900 tons.

Owing to the numerous rises and dips in the Robertsdale slope the head- and tail-rope would strike and rub against the roof at some points. This caused undue wear on the wire strands. To obviate this, the track was curved to one side a short distance above, and then back to the line of the slope below that point. Alongside the track at that point a post was securely placed and a sheave wheel bolted (vertically) thereon. Then when the rope rises from the track it strikes the groove in the sheave and the wear is minimized.

At the Woodvale shaft of the same company a large steam hoist is situated near the shaft bottom. This hoist performs work similar to the electric hoist referred to at the bottom of the Robertsdale slope. In this case, however, the steam hoist has a unique distinction, in that it hoists coal from three different counties.

The Rockhill company has many pumps of various sizes. Most of these are small ones whose use is imperative owing to the numerous dips in the seam. All are electrically or air driven save the large Scranton steam pump at the bottom of the Woodvale shaft. This pump draws from a 3,000,000-gallon sump and pumps the water to the surface 200 feet above.

Ventilation in the East Broad Top mines is good. A blower fan is commonly used owing to wet slopes or shafts. In this respect, the Woodvale shaft fan is novel (Fig. 5). Instead of the neck or discharge of the 14′ × 5′ double-inlet Connellsville fan being of the same width as the fan itself it is here widened out in every direction to a 10′ × 10′ size in order to fit the 10′ × 10′ concrete air-shaft. This effectually prevents any choking of the air and is not unlike the evasé chimney. The fan is of 200,000 cubic feet capacity at 7 inches of water gauge.

Crossing the Broad Top Arch going west from Robertsdale, the surface slopes sharply down to Six-Mile Run. From the beginning of this stream to the Raystown branch of the Juniata at Riddlesburg, the topography is similar to that of central West Virginia. There seems to be no general direction of the ridges. The coal lies in successive basins running almost N 45° E.

At Finleyville, Bedford County, the J. M. McIntyre Co. operates the Shreeves Run mine with an output of about 800 tons per day from three drifts in the Kelly seam and 150 to 200 tons from a drift in the Barnett. At this point the Barnett is a better grade of coal. It contains but 3 per cent. of ash while the Kelly averages as high as 8 or 10 per cent.

A freak occurrence in mine operation is present at this mine, due to the rolling seam. A drift is being operated at the tipple level in the Kelly seam, Fig. 7. Alongside this opening is a plane extending 960 feet up the mountain side to another drift. The second drift is 360 feet higher in elevation than the first and is in the same seam.

At the Ladysmith mine of the Schipper Brothers Mining Co., near the town of Six-Mile Run, the three seams are present but only the Kelly and the Barnett are being mined.

Fig. 6. Steel Mine Car Used at Robertsdale

Two drifts are in the Kelly seam, one at the tipple level and 800 feet to the west, the other 250 feet directly above the tipple on the mountainside. The third drift is in the

Barnett seam, 1,800 feet east of the tipple. Mule haulage is used. The Kelly drifts are on the western side of the anticlinal in what is known as Crescent No. 2 basin. The Barnett drift is on the eastern side, and is in the Cumberland basin. It is hard to keep up the roof in the Fulton, for although it is extremely hard, the air slacks it and it soon becomes soft.

The feature of the Schipper company operation is the tipple. It is novel to the Broad Top region. There are thousands of such tipples throughout the country, but it is the only one in the district where the coal is sized, notwithstanding the fact that the region produces over a million and a half tons each year.

The tipple consists of a Link-Belt reciprocating feeder and a 45-foot picking table. The coal then passes over an 8-inch bar screen. This gives two sizes, lump and a combination of nut and slack. When the Barnett coal is being run over the table the coal is diverted into another chute at the end of the table and runs into the cars as run of mine. This is because the Barnett coal does not make as good lump coal for domestic use as the Kelly at this point. A 7½-horsepower motor drives both the feeder and the table.

Further down the valley, at Riddlesburg, the Colonial Iron Co. operates the Judith mine, a drift in the Kelly seam at that point. The entire output of the mine is coked for the iron furnace at the mine.

The three important seams in the field, the Fulton, Barnett, and Kelly are all coking coals. Owing to the high percentage of sulphur in the Barnett at some places its coke is inferior to that of the Fulton or the Kelly.

The Broad Top coke has proved to be excellent for iron furnace use. It is tenacious and strong, and carries the ore load without breaking. It does not, however, possess the bright columnar and fibrous structure of the Connellsville coke. The coal has been coked in the regions since 1846. In analysis it compares favorably with Connellsville coke, the principal difference being a slightly greater amount of water and about 1 per cent. more sulphur on the part of Broad Top coke made from coal of the Fulton seam. Coke made from the Kelly coal is only slightly greater than the Connellsville in sulphur content.

On a high hill known as Rogers Knob, at Riddlesburg, is one of the

FIG. 7. PLANE AT SHREEVES RUN MINE

rare points where the Pittsburg seam is to be seen in the field. Some idea can be gathered of the tremendous erosion that has taken place when this isolated little area is noted.

A striking feature of the field is the total absence of firedamp. This permits the universal use of open lights. The coal does not contain any gas of itself and the crushed and broken condition of the strata prevents gas accumulation.

A visitor to the region is struck by the absence of any elaborate tipples or large outlay in sociological or welfare work. This has been ascribed to a number of reasons. The most logical, however, are the complex nature of the coal, the absolute unreliability of a seam remaining on any constant pitch, the variations in the sandstone parting in the seam and in some cases extremely high haulage costs. All these conditions demand a conservative financial policy on the part of the operator. They above all, tend to prevent a liberal expenditure of capital such as is warranted in other fields. Even diamond drills do not give positive information, although drilling is being done at present. There may be a dozen small anticlines and synclines between one known point and another as shown by a diamond drill. Present drilling operations are being conducted more to define the extent of the field than to project mine working methods.

Fossil Resins in Coal

The importance of coal in national development and in the progress of the world renders any new information in regard to it of interest. Concerning the formation and source of coal there have been many and divergent opinions. It is now generally conceded that coals of various ranks, from lignite to bituminous and anthracite, are derived from peat. The vegetation going to make up the peat ranges from minute plants floating about upon the surface of a bog to large trees. These plants, on dying, settle to the bottom of the bog, where, mainly through the agency of bacteria, they decay. The partial decay of the vegetable matter and its consolidation forms peat. Through still further consolidation the peat forms lignite, and this in turn, as the result of various processes, forms coals of higher rank.

Many plants are known to exude gums and resins, especially when injured. A well-known fossil form of such resin is amber, in which insects are frequently found imbedded, having been caught and imprisoned by the gum while it was still soft. In the more recent coals of lower rank, fossil resin occurs in abundance, in the form of small lumps or flakes. In the coals of higher rank, resins are not readily seen, and their occurrence in such coals has been doubted. It has been supposed that these coals were formed from a different type of vegetation in which resin did not occur. In the United States Geological Survey, Professional Paper 85–E, David White discusses at

length the occurrence of resin and gums in coals and proves that they are present not only in the later coals of the Western States of both high and low grade, but in the old Paleozoic coals of the Eastern States. Mr. White's conclusions are of particular interest as showing that the high and low rank coals were derived from similar types of plants and differ only in the degree of alteration of the vegetable matter from which all coals are derived.

In the paper the course of the resin is followed from the living plant to its elimination in the high-rank coals. The amount of resin in peat and in the coal subsequently formed is largely determined by the amount of decay of the vegetable matter. The resin, being most resistant to decay, increases proportionally in volume the greater the destruction of the woody tissue. A high percentage of resinous matter gives "fatty" coals. The volatile and high-heating cannel coals have a large proportional amount of resinous matter. In the formation of coals of higher rank, a sort of distillation takes place, brought about for the most part by movements within the earth's crust, such, for instance, as have formed the Appalachian mountain system. As a result of this natural distillation the amount of volatile matter in the coal becomes less. The resins are reduced, probably leaving a part of their carbon within the coal. In the highest-grade coals the resins apparently are obliterated as such.

To those interested in the matter, either scientifically or commercially, the paper will prove of value as explaining the reason for certain qualities and characteristics of various types of coal. A copy of the paper may be obtained by writing to the Director of the United States Geological Survey, Washington, D. C.

Practically all the coke produced in Nova Scotia comes from by-product ovens. Three briqueting plants are dependent on these ovens for binder. By-product ovens pay every way.

A Modern Rotary Drill

*By Howard R. Hughes**

The rotary method of drilling, as its name implies, involves the rotation of a pipe by means of machinery placed on the derrick floor. A drill bit attached to the lower end cuts a clearance for the drill pipe, with much the same motion and effect as an auger. Water forced through the drill pipe by means of a pump, and escaping through the bit, removes the cuttings and returns to the surface outside the drill pipe.

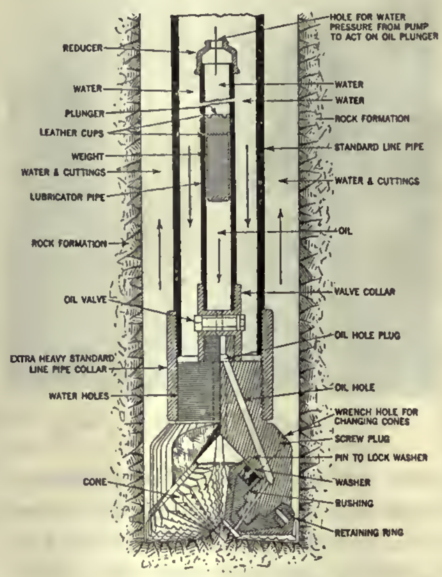


Fig. 1. Drill Using Cone Bit

In this manner the hole is kept open, permitting the drill stem to rotate freely.

The pressure of the column of muddy water holds up the walls of the hole until it has been cased.

Practically all the wells of the Gulf Coast region, numbering nearly 10,000, have been drilled with this system, but the fishtail type of bit commonly used has not been so efficient in hard formations. For use in rock, the cone bit was invented. This consists of two or more detachable, cone-shaped, cutters of hardened steel revolved in a holder, as shown in Fig. 1. These cutting cones revolve on bronzed bearings, lubricated with a special heavy viscous oil supplied by means of a small pipe carried inside the drill stem. The cutters, being detachable, may be removed and sharpened when dull.

In cutting, the edges, or cone points, of the bit-roll in a true circle, like a cone bearing, and crumble or chip away the rock. The cone points, being of very hard steel, wear away slowly. Often they show but slight wear after drilling 50 feet of rock, a few inches of which would completely dull the ordinary fishtail bit. The rolling motion allows the cutting edges on the cones to chip the rock, one edge after another.

Fig. 1 shows the bit, drill pipe, and lubricator, in the hole, ready for drilling. The lubricator pipe, about 12 feet long, is filled with oil, which is forced down into the bit by the pressure of the circulating water on the plunger. This figure shows also that the bottom of the drill hole as formed by the operation of the bit presents a perfect seat for a water-tight joint, preventing leakage after the casing has been set.

The proper adjustment of weight upon the bit is the secret of good work with this drill. Comparative costs of work with this bit and the fishtail bit are given in the article from which this is taken. While primarily designed for oil and water wells, this drill can be applied in drilling sump holes for mine pumps, and in driving holes inclined at various angles from the vertical.

*Houston, Tex. Abstract from article in Transactions American Institute of Mining Engineers, March, 1915.

Educating the Miner

According to Professor Norwood a practical man is a man who is capable of applying knowledge to some useful end. He may have obtained that knowledge in a school or through experience or both ways. When we speak of a "practical miner" we think of some one who has been educated only by practice or experience. If the practice where he learned was bad, he is unfortunate, for a miner whose experience has been gained in a mine whose manager says "he does not want educated miners," is not a good man to pattern after or put in charge of important work anywhere.

The Top Telescope Problem

General Rule For Finding the Correction Angle to be Applied to the Vertical Angle Read With the Top Telescope

By F. W. Sperr*

Figs. 1, 2, 3, and 4 illustrate some of the positions of the transit that are required for various observations and measurements which have to be made for the determination of horizontal and vertical distances between points, with the use of the top telescope.

DEFINITION OF TERMS

The distance measured from the point at which the instrument is stationed is the point distance or *PD*.

Distance measured from the horizontal axis of the instrument is instrument distance or *ID*.

The measured distance, if taped directly to the point beyond the instrument, will be either a point distance, *PD*, or an instrument point distance, *IPD*, depending upon whether it is measured from the station point or from the horizontal axis of the instrument; if taped to a suspended lamp, it will be either a point lamp distance, *PLD*, or an instrument lamp distance, *ILD*.

The vertical distance from the station point to the horizontal axis of the instrument is *HI*, plus if upward and minus if downward.

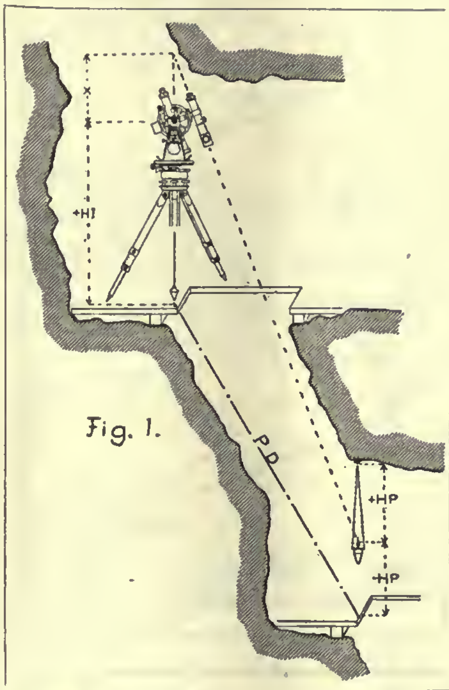


Fig. 1.

The vertical distance from the lamp to the point at which it is suspended and to which the traverse is being carried, is *HP*, plus if upward and minus if downward.

It is best to make the measurement from fixed point to fixed point; but such measurements are not always possible on account of obstructions that sometimes intervene between consecutive points of the traverse. The straight line measurement *ILD* is always possible, else the sight could not be taken; but it is liable to be made inaccurately, because neither terminal is rigid. The *ID* and the *PLD* are to be preferred to the *ILD*, whenever practicable; and the *PD* is to be preferred to any other method of measurement whenever it can be used.

Figs. 5 to 37 indicate the different

(Continued on Page 526

*Professor of Civil and Mining Engineering, Michigan College of Mines.

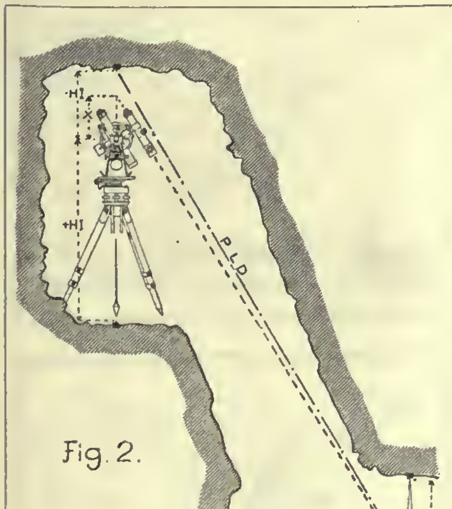


Fig. 2.

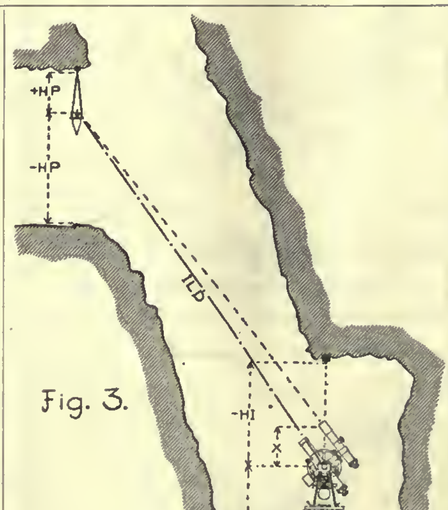


Fig. 3.

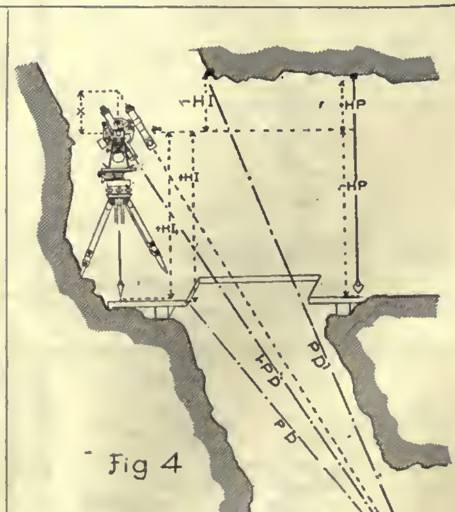


Fig 4

SYMBOLS EMPLOYED in MINE SURVEYING

NOTES

β = Angle between Line of Sight and Measured Line
K = Vertical Angle
C = Horizontal Distance.
D = Measured Distance
E = Difference in Elevation
H = Height.
I = Instrument
L, * = Lamp.
P, o = Point.
• = Horizontal Axis of Instrument.
d = Distance between Top Telescope and Horizontal Axis of Instrument.
∢ = Horizontal Angle.

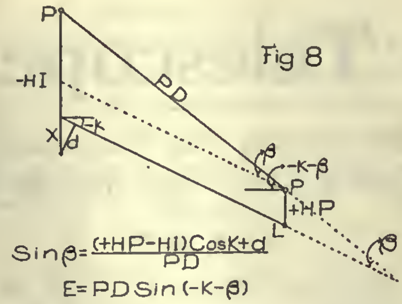


Fig 8

$$\sin\beta = \frac{(+HP-HI)\cos K + d}{PD}$$

$$E = PD \sin(-K-\beta)$$

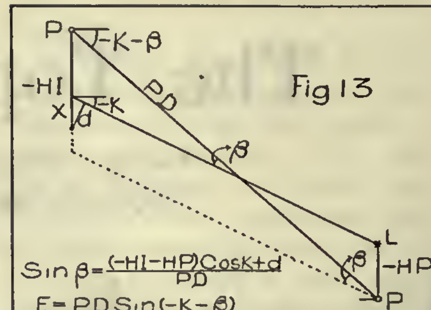


Fig 13

$$\sin\beta = \frac{(-HI-HP)\cos K + d}{PD}$$

$$E = PD \sin(-K-\beta)$$

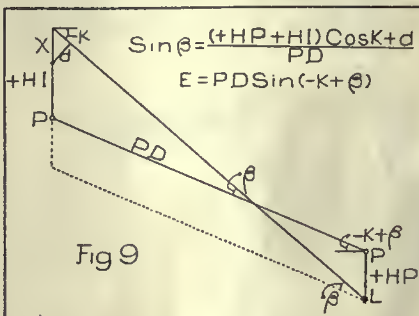


Fig 9

$$\sin\beta = \frac{(+HP+HI)\cos K + d}{PD}$$

$$E = PD \sin(-K+\beta)$$

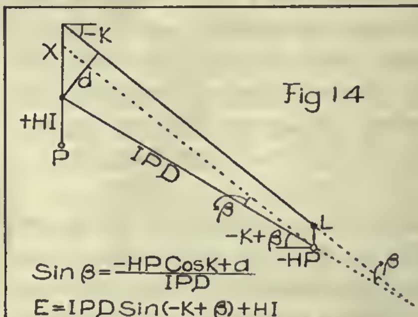
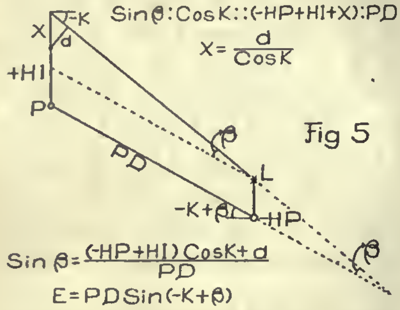


Fig 14

$$\sin\beta = \frac{-HP\cos K + d}{IPD}$$

$$E = IPD \sin(-K+\beta) + HI$$



$$\sin\beta : \cos K :: (-HP+HI+X) : PD$$

$$X = \frac{d}{\cos K}$$

Fig 5

$$\sin\beta = \frac{(-HP+HI)\cos K + d}{PD}$$

$$E = PD \sin(-K+\beta)$$

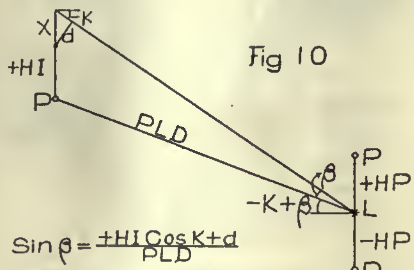


Fig 10

$$\sin\beta = \frac{+HI\cos K + d}{PLD}$$

$$E = PLD \sin(-K+\beta) \pm HP$$

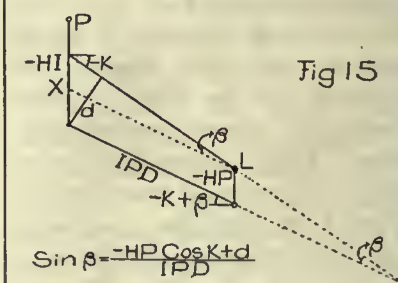


Fig 15

$$\sin\beta = \frac{-HP\cos K + d}{IPD}$$

$$E = IPD \sin(-K+\beta) - HI$$

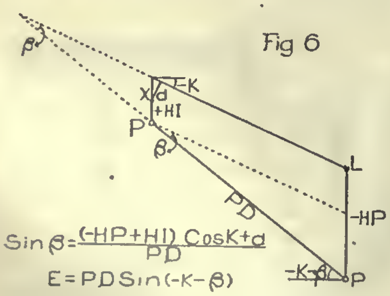


Fig 6

$$\sin\beta = \frac{(-HP+HI)\cos K + d}{PD}$$

$$E = PD \sin(-K-\beta)$$

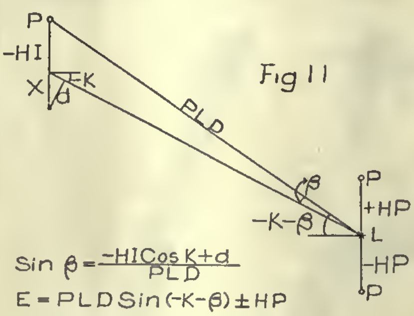


Fig 11

$$\sin\beta = \frac{-HI\cos K + d}{PLD}$$

$$E = PLD \sin(-K-\beta) \pm HP$$

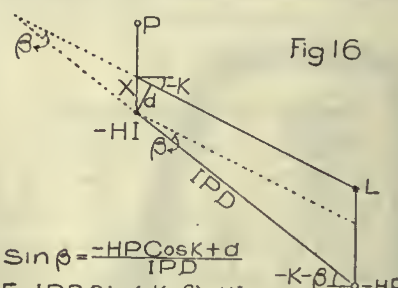


Fig 16

$$\sin\beta = \frac{-HP\cos K + d}{IPD}$$

$$E = IPD \sin(-K-\beta) - HI$$

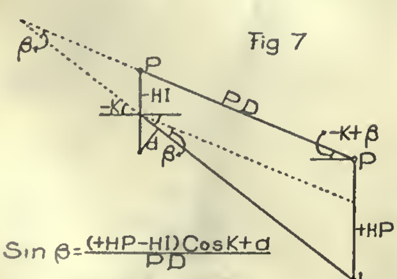


Fig 7

$$\sin\beta = \frac{(+HP-HI)\cos K + d}{PD}$$

$$E = PD \sin(-K+\beta)$$

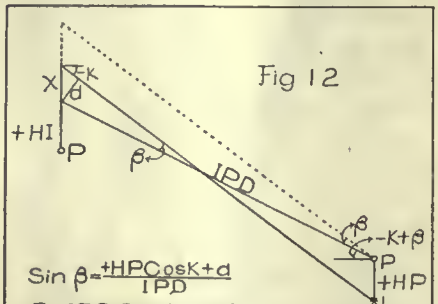


Fig 12

$$\sin\beta = \frac{+HP\cos K + d}{IPD}$$

$$E = IPD \sin(-K+\beta) + HI$$

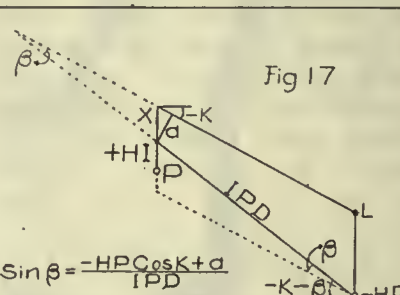


Fig 17

$$\sin\beta = \frac{-HP\cos K + d}{IPD}$$

$$E = IPD \sin(-K-\beta) + HI$$

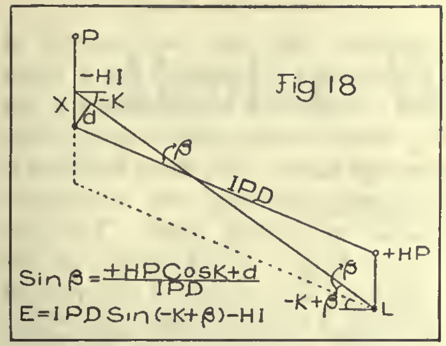


Fig 18
P
-HI
X
-K
d
β
IPD
+HP
L
-K+β
Sin β = +HP Cos K+d / IPD
E = IPD Sin (-K+β) - HI

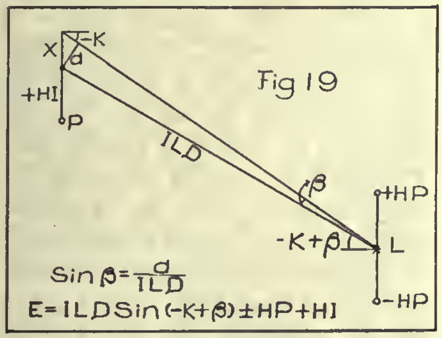


Fig 19
X
-K
d
+HI
P
ILD
β
+HP
L
-HP
-K+β
Sin β = d / ILD
E = ILD Sin (-K+β) ± HP + HI

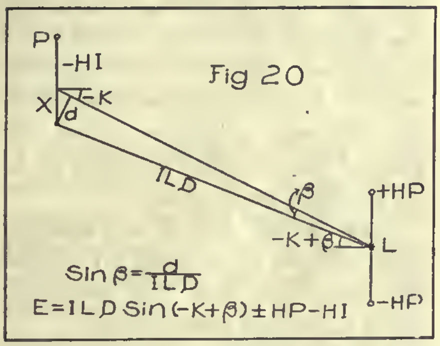


Fig 20
P
-HI
X
-K
d
ILD
β
+HP
L
-HP
-K+β
Sin β = d / ILD
E = ILD Sin (-K+β) ± HP - HI

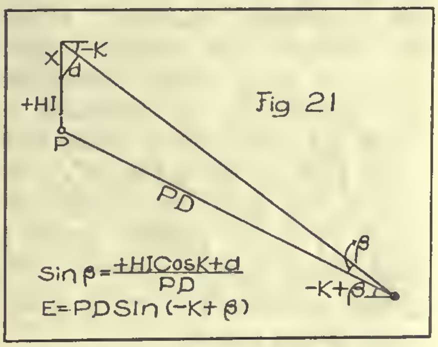


Fig 21
X
-K
d
+HI
P
PD
β
-K+β
Sin β = +HI Cos K+d / PD
E = PD Sin (-K+β)

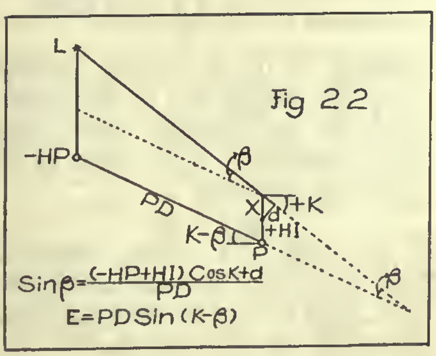


Fig 22
L
-HP
PD
β
X
+K
+HI
K-β
P
Sin β = (-HP+HI) Cos K+d / PD
E = PD Sin (K-β)

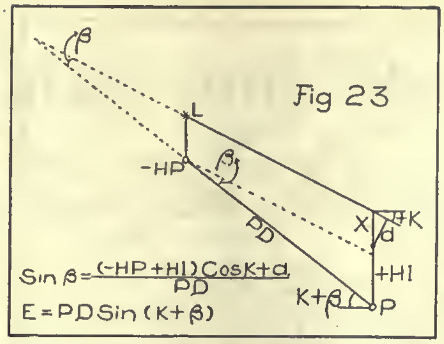


Fig 23
β
L
-HP
PD
X
d
+K
+HI
K+β
P
Sin β = (-HP+HI) Cos K+d / PD
E = PD Sin (K+β)

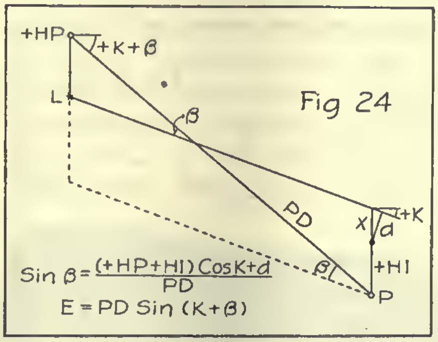


Fig 24
+HP
+K+β
L
β
PD
X
d
+K
+HI
P
Sin β = (+HP+HI) Cos K+d / PD
E = PD Sin (K+β)

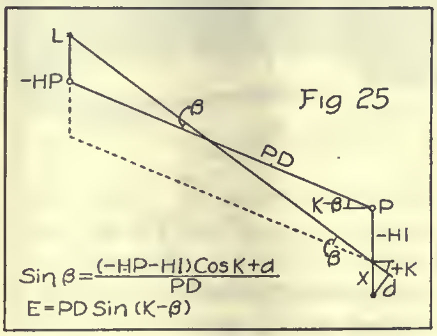


Fig 25
L
-HP
β
PD
K-β
P
-HI
X
+K
d
Sin β = (-HP-HI) Cos K+d / PD
E = PD Sin (K-β)

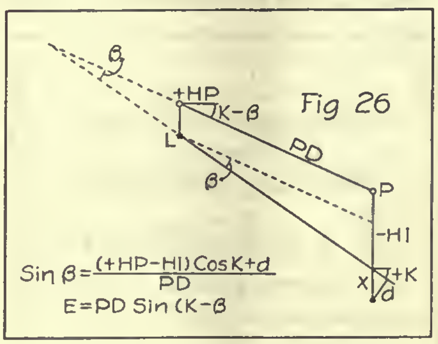


Fig 26
β
+HP
K-β
L
PD
P
-HI
X
+K
d
Sin β = (+HP-HI) Cos K+d / PD
E = PD Sin (K-β

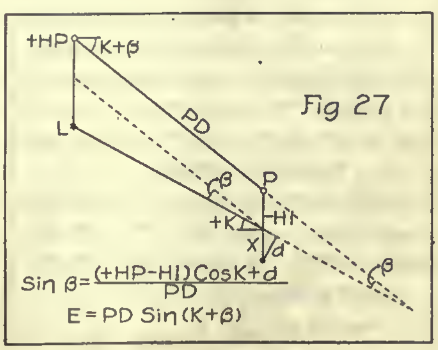


Fig 27
+HP
K+β
L
PD
β
P
+K
-HI
X
d
Sin β = (+HP-HI) Cos K+d / PD
E = PD Sin (K+β)

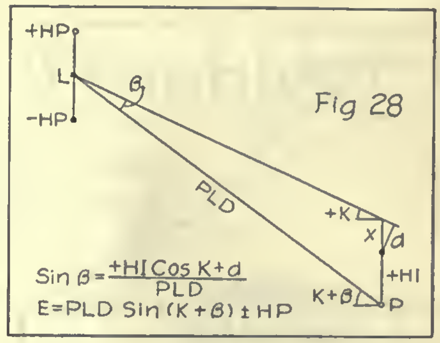


Fig 28
+HP
L
-HP
β
PLD
+K
X
d
+HI
K+β
P
Sin β = +HI Cos K+d / PLD
E = PLD Sin (K+β) ± HP

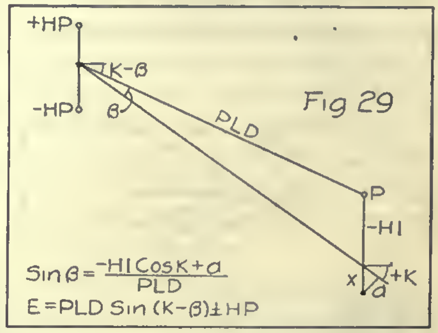


Fig 29
+HP
K-β
-HP
β
PLD
P
-HI
X
+K
d
Sin β = -HI Cos K+d / PLD
E = PLD Sin (K-β) ± HP

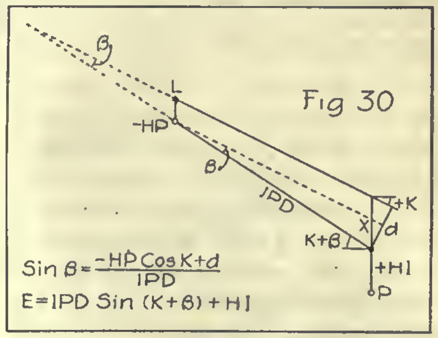


Fig 30
β
L
-HP
β
IPD
+K
X
d
K+β
+HI
P
Sin β = -HP Cos K+d / IPD
E = IPD Sin (K+β) + HI

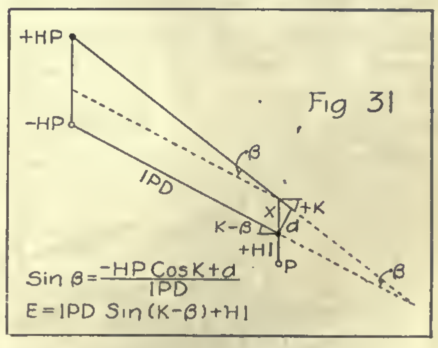


Fig 31
+HP
-HP
β
IPD
X
+K
K-β
d
+HI
P
Sin β = -HP Cos K+d / IPD
E = IPD Sin (K-β) + HI

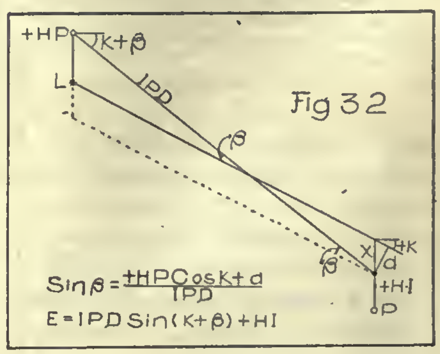


Fig 32
+HP
K+β
L
IPD
β
X
+K
d
+HI
P
Sin β = +HP Cos K+d / IPD
E = IPD Sin (K+β) + HI

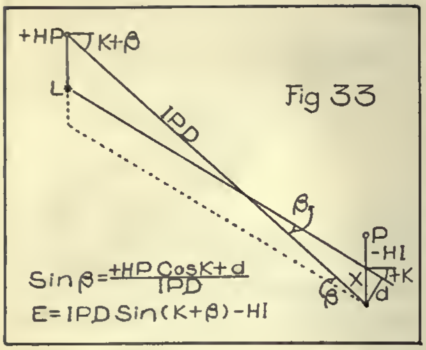


Fig 33

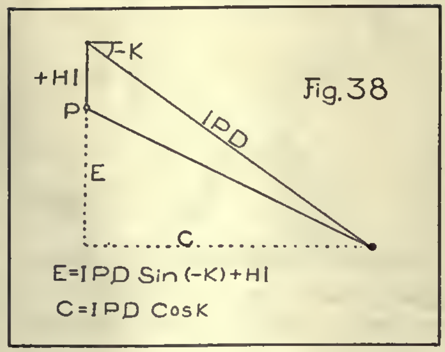


Fig. 38

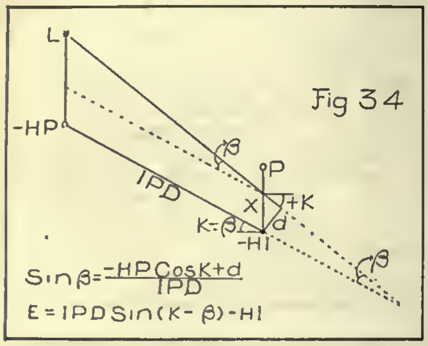


Fig 34

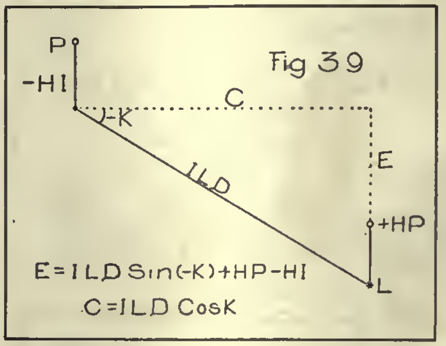


Fig 39

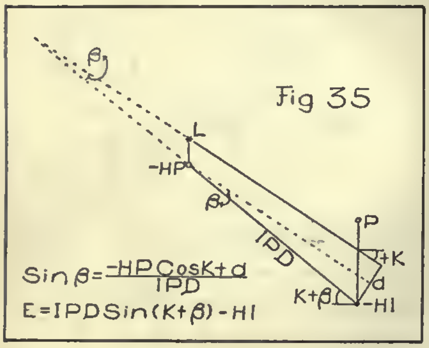


Fig 35

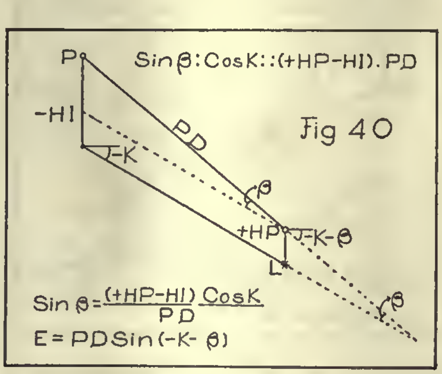


Fig 40

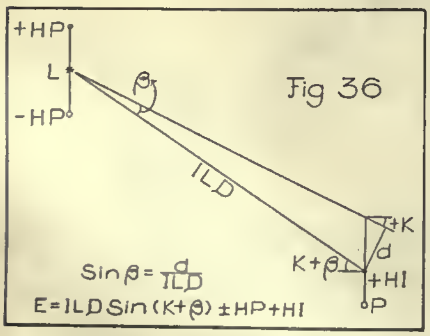


Fig 36

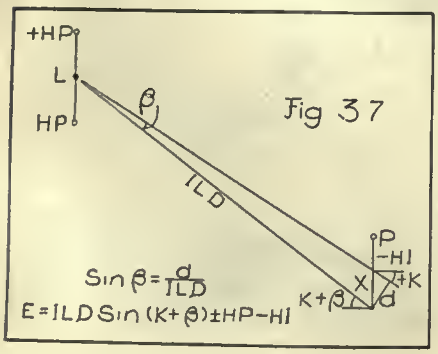


Fig 37

GENERAL FORMULAE for all PRECEDING PROBLEMS:

$$\sin \beta = \frac{(\pm HP^1 \pm HI^2)\cos K + d^3}{D}$$

$$E = D \sin(\pm K \pm \beta) \pm HP^4 \pm HI^5$$

$$C = D \cos(\pm K \pm \beta)$$

[1] HP = 0 when D is measured to the Lamp and when Lamp and Point coincide.
[2] HI = 0 when D is measured from the Axis of the Instrument.
[3] d = 0 when the Sight is taken with the Main Telescope.
[4] HP = 0 when D is measured to the Point and when Lamp and Point coincide.
[5] HI = 0 when D is measured from the Instrument Station Point.

(Continued from Page 523)

solutions that may be involved in finding the correction angle when the transit with top telescope is set up either directly over or directly under the station, and when the lamp is suspended directly over or directly under or on the point. The corrected angle is the result of the algebraic summation of the vertical angle and the correction angle. The algebraic sign of the vertical angle is + if sighted upward, and − if sighted downward. Geometrically, the vertical angle is either in the first quadrant or in the fourth; therefore its cosine is always plus. The algebraic sign of the correction angle depends upon the algebraic sign of its sine, which is determined by the sign of the algebraic summation of the numerator of the fraction in the equation for sin β. The algebraic sign of the denominator of the fraction is always + because it is distance forward from the observer. By bringing together all of the different equations under the general formula that follows Fig. 40, we have the general rule.

Figs. 38, 39, and 40 are made to illustrate the elimination of d from the equations for the correction angle in certain specific cases.

Fig. 4 is made to illustrate a number of different conditions. Where the distances are measured from points in front of the instrument, the special case is illustrated in which the instrument is set up on a ledge back of the principal survey point in the shaft. This makes the "back of shaft" problem which is often found quite convenient. The general equation for the correction angle in this case is

$$\sin \beta = \frac{HI \cos K + L \sin K + d}{PD}$$

where L is the horizontal distance from the vertical axis of the instrument to the principal point, and other elements are the same as in preceding problems.

Magnesite is a mineral which is over 52 per cent. carbon dioxide, the gas which is used for charging soda water and similar beverages.

Boiler Water and Its Troubles

Substances Which When Present in the Water Cause Damage and Expense by Chemical or Mechanical Action

By C. M. Young

AT THE center of every industry of manufacture or transportation is a power plant—in most cases a steam boiler and a steam engine. The steam boiler, in its essentials, is a firebox to burn the fuel and a tank to hold the water. The great coal mining industry has grown up with the modern demand for fuel. This use of fuel for the production of power has been deeply studied and there is considerable literature on the subject of coal, covering its heat value, its impurities, its different sizes, the shapes and dimensions of fireboxes, designs of grates, methods of firing, etc.

But the water in the boiler is just as essential for the production of steam as is the coal on the grate, and the character of the water has as much to do with the cost of operation and repairs. It is this which determines the conditions of the boiler and has much to do with efficiency, length of service, cost of repairs, and safety.

Not all natural waters are fit to put into boilers. Some are so bad as to be past treating; some can be helped and made tolerable by judicious treatment, and some are so good that treatment would be of no value and would really do more harm than good.

The fact that many natural waters are ill suited for use in boilers has been the cause of great expense to the developers of steam power, and has led in many cases to the adoption of measures for the modification of the water available. Several companies engaged in the treatment of boiler water have developed the art to a high point and are able to produce good results in such cases as they are willing to undertake. Unfortunately, the success attained by truly scientific work in some cases has led to the promotion of schemes which can be best described as fakes. Treatment is not for the careless or uninformed; it requires knowledge and judgment. It is not a panacea. It may not make bad water good, but it may make it much better. Probably the best evidence of the real success of boiler water treatment is found in the facts that many companies devote themselves exclusively to this subject, and that thousands of tons of chemicals are used every year in the treatment of water. Also many large industrial plants have designed and built their own treating plants. One railroad company which handles a heavy traffic over a short line in a district of bad water, has built fifteen treating plants at a cost of $250,000. This company spends about $20,000 per year for chemicals.

Boiler Upside Down, Showing Bags Due to Sediment

An indication of the magnitude of the losses involved in the use of bad water is found in the fact that one of the principal railroads entering Pittsburg estimates its annual loss due to the character of water used at about $500,000. Another road in the same district could develop 25 per cent. more power with good water. Both of these companies employ extensive treating systems. One day one of the Pittsburg steel plants sent to another for 700 boiler tubes. As there were not so many spare tubes in stock, all the locomotives that could be spared were sent and these were connected to the steam lines and the operation of the plant continued. But this was before water was treated at these plants, really before the treatment of water had become as much an art as it now is.

During the dry weather of last summer several coal companies were obliged to suspend operations for lack of suitable water. One of the largest of the Pennsylvania companies installed temporary plants for the treatment of mine water and continued operations, using treated mine water for boilers, quenching coke, and domestic purposes.

Figures have been given for railroads simply because they are at hand. All users of bad water suffer in proportion to the badness of the water and the amount used. Commonly, it is the large industries that know and appreciate the damage and apply the remedies, but the loss is just as great proportionally to small plants as to large ones and the improvement of the water is just as essential to economical operation.

The evils resulting from the use of impure waters are of various kinds, depending on the character of the impurities, the temperature of the boiler, the treatment of the water before it is fed to the boiler, etc. These troubles may be put under four general heads.

(*a*) Precipitation of mud. Much water contains matter in suspension and is turbid or muddy. This suspended matter accumulates in the boiler. A large part of it collects in the mud-drum from which it can be blown out. Sometimes alone or in

conjunction with other substances it accumulates to considerable thickness and may bake onto the plates. When it settles out of suspension it acts as an insulator, and if it accumulates on a plate exposed to heat, that is, anywhere except in a mud-drum in most boilers, it may cause bagging or even rupture of the plate. The temperature of the fire is high enough to melt or soften the iron. The metal is exposed to this temperature and would become dangerously heated if it were not for the constant loss of heat to the water. Any accumulation of mud or scale impedes the transfer of heat, with the consequences that the gases are less cooled, that is, more of the heat value is lost, and that the iron becomes hotter than it should.

(*b*) Foaming. Sometimes steam does not escape quietly from the water but forms a mass of foam. In such cases it is impossible to tell how much water is present in the boiler, and there is danger that the boiler may become nearly empty before the condition is discovered. When the foam passes over into the pipes and engine we have priming. The efficiency of the engine is, of course, lowered and there is danger of a cylinder explosion because of the inability of the exhaust ports to handle the water accompanying the steam. Wet steam interferes with lubrication because the mineral oils which are the best lubricants do not adhere to wet surfaces. To aid lubrication, vegetable and animal oils are added.

Foaming is caused in several ways. Sometimes animal or vegetable matters increase the viscosity of the water, and in some cases oils are saponified, with the result that the water acts like, or is, a soap solution. Sometimes a scum is formed which prevents the ready escape of the steam. Sometimes a soluble substance is so concentrated by the evaporation of water that the surface tension is changed and foaming occurs. The use of sodium carbonate to remove calcium sulphate from water, results in the formation of sodium sulphate, and it has been found that this substance causes foaming when present in the amount resulting from the use of 2 pounds of sodium carbonate per 1,000 gallons. Solid particles in suspension will cause it. These may exist in the feedwater or may be precipitated from it in the boiler.

(*c*) Scale is an accumulation of mineral substances precipitated from water on the sheets and tubes of the boiler. Scale is commonly divided into hard and soft, though there is no sharp dividing line between them. The difference is in the physical hardness and density of the substances.

The accumulation of scale retards the transfer of heat from the gases to the water. The effect is considerably greater with hard scale than with soft because its greater density prevents the circulation of water in the scale. There are no reliable figures on the loss of efficiency caused by scale, and probably it would be impossible to obtain any of general application, because scale is composed of several different substances; and even in those cases where its chemical composition is the same, there will be differences in physical structure due to different conditions attending its deposition, such as temperature of the gases, rate of evaporation, etc. As an illustration of the variability of scale, it may be said that sometimes there is considerable difference in the boilers of a single battery, where all of the boilers are of the same type and size and are fed with the same water. Even under such circumstances, where uniformity of conditions seems to exist, it will sometimes be found that one boiler will be quite heavily coated with scale while another may be free. No satisfactory explanation has been found.

Not only may the deposition of scale be variable, but it may produce different effects. This is illustrated by the case of a boiler fed with water containing 100 parts per million of scale forming substances. Normally this boiler was operated at 120 pounds pressure and the scale gave no trouble; but when it became necessary to force the boiler and the pressure was raised to 185 pounds the scale gave trouble because the temperature of the gases was higher, and while the thin scale had allowed the transfer of sufficient heat to the water to keep the tubes cool while the boiler was operated at low pressure, this was not the case when the pressure was increased. The scale was decomposed and the tubes corroded.

(*d*) Corrosion is a dissolving of the metal of the boiler. As the metal is not uniform in composition the corrosion is deeper in some places than in others and pitting results.

The occurrence of the various troubles which have been mentioned can be understood by the consideration of water and the substances which it may contain. Water is a chemical compound of hydrogen and oxygen, and is one of the best of solvents, in fact there are very few substances which are insoluble in it. Until recently it was assumed that water consisted entirely of the chemical compound H_2O, but it is now believed that part of the water is dissociated into H and OH and that these ions, as they are called, have properties quite different from those of the undissociated molecules.

The water which falls from the clouds in rain absorbs certain gases, the principal ones of which are oxygen, nitrogen, and carbon dioxide. In the neighborhood of important industrial districts, considerable amounts of sulphur compounds, which result from the burning of the sulphur of the coal, may be found in the air, and these will be absorbed.

When the water falls upon the earth's surface it begins to absorb substances exposed to its action. If it passes through decaying vegetable matter it absorbs additional amounts of carbon dioxide, and in some cases it absorbs appreciable amounts of the acids resulting from the decay of the vegetable matter. In most cases, however, these are insignificant. If decaying animal matter is

(Continued on Page 571)

The Burning of Pulverized Coal

The Process and Apparatus Used in the Portland Cement Industry and in the Raising of Steam

By R. C. Carpenter and F. R. Low*

THE process of burning powdered coal has been developed in but few arts and only in relation to certain types of furnaces. For more than 30 years various schemes for burning powdered coal in boiler furnaces have been suggested and numerous patents have been taken out on various processes and burners, but without any marked degree of success. In the Portland cement industry, commercial success was attained more than 15 years ago as a result of a series of investigations and experiments. The furnace employed had much to do with the practical success which was finally attained, and for that reason its construction and mode of operation will be briefly described.

Portland cement is manufactured from a mixture of materials containing lime and silica which are brought together in definite proportions to produce a chemical combination. The raw material is principally carbonate of lime, or limestone in some form, and clay or shale. The materials are pulverized

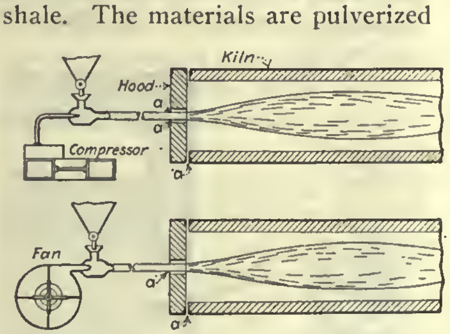


Fig. 1. Diagram of Burner and Kiln

raw, and mixed in proper proportions. The raw mix is introduced into a kiln, either in the form of a dry powder or in a wet and plastic condition, where it is subjected to an extremely high temperature and in which the required chemical combinations take place.

During the early years of the Portland cement industry in this country, oil was employed as a fuel.


Fig. 2. Section, Atlas Burner

This was sprayed into the lower end of the furnace with a jet of compressed air or steam. The oil was employed successfully, but, due to the increasing cost after 1895, its use was too expensive. From 1897 to 1900, the increase in price was such as to make the use of oil nearly prohibitive from a commercial standpoint, and was the principal incentive for developing the use of pulverized coal.

In 1894, a series of experiments relating to the use of pulverized coal was started by the Atlas Portland Cement Co., in charge of Messrs. Hurry and Seaman, chief engineer and superintendent, respectively. These experiments led to many discoveries, the invention of various parts, and finally to the commercial development of the art.

The art as at present developed consists of a process for delivering to the kiln the powdered fuel or fuel dust by a jet of air, which impinges on the fuel dust in an injector with force enough to discharge the dust into the kiln. The compressed air may be obtained from a fan or compressor whichever may be convenient. The fuel dust enters the combustion chamber of the kiln in the form of a black cloud and burns in the form of an elongated torch as shown in Fig. 1.

The problem of powdered fuel is one of combustion under peculiar conditions. Its burning differs from that of solid fuel, from a theoretical standpoint. In the burning of commercial sizes on the grate, the air passes between the pieces of coal, and the products of combustion pass off in the flues. Coal dust does not burn under such conditions, as the particles are so fine that the coal forms a blanket, smothering any flame. To burn powdered coal successfully, it must be burned while in suspension in the air. In such a position each particle is surrounded by air supporting the combustion. The long cylindrical furnace used in the cement industry is obviously favorable for combustion in suspension.

Contact of the particles of coal dust with other bodies results generally in the lowering of temperature to such an extent that combustion is impossible. The result is the virtual loss of any fuel which falls onto the lining or the clinker. The time of combustion is evidently increased as the size of the dust particles is increased, hence the finer the grinding, the quicker and more perfect the combustion.

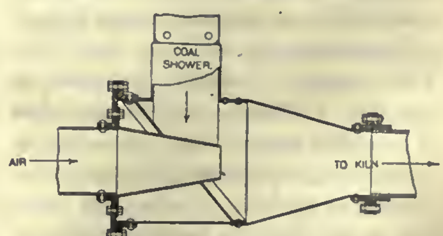


Fig. 3. Low Pressure Burner

The fuel for burning in Portland cement kilns can have a wide range of quality. The best bituminous coals are preferable, but those of quite poor quality are in successful use. Anthracite has been used successfully at different times, but it is

*An abstract from papers read before the American Society of Mechanical Engineers at St. Paul, Minn., June, 1914.

difficult to pulverize and requires a high temperature for combustion.

Before the coal is ground it is dried so that the moisture content will be less than 1 per cent., as the water in coal seriously affects the operation of pulverizing. It also has a detrimental effect on feeding

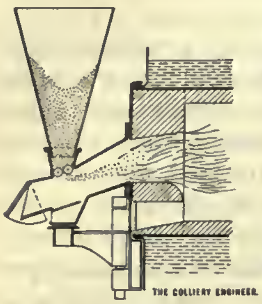


Fig. 4. Pinther Apparatus

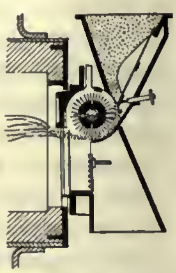


Fig. 5. Schwartzkopff Apparatus

and on the capacity of the kiln. The effect of the moisture, however, depends upon the kind of coal, so that no limit can be definitely stated as essential to success in advance of a trial.

The operations required for burning pulverized coal consist in drying, pulverizing, conveying, storing, and feeding.

The coal to be dried is fed into the upper end of the cylindrical drier and is discharged through a stationary hood at the lower end. Drying is accomplished by direct contact with hot gases which enter the cylinder through the hood at the discharge end. The dried coal is discharged into conveyers and removed to bins over the pulverizing machines. This adds to the efficiency and capacity of the drier but also increases somewhat the danger of conflagration while in the drier. This danger is slight, however, in practice; and with good construction it is quite certain not to result in serious damage, and can always be prevented by care, so that the practice is not open to serious criticism.

The coal, if delivered in large lumps, is broken into small pieces by passing through crushers, before entering the drier. It must be so fine that not less than 92 per cent. will pass a sieve of 100 meshes to the linear inch. It is desirable to have the coal still finer. The pulverizing machinery employed is adapted to two systems of dust burning. In the first system the pulverizer is arranged to deliver its product directly into the kiln without intermediate storage. It has a capacity of supplying but one kiln and is not widely used. In the second system the pulverizers have large capacities and the coal is stored temporarily before being fed into the kiln. This method is used almost exclusively in the cement industry.

Conveying machinery differs greatly in the different mills. The requisite for safe conveying is the prevention of an explosive mixture of pulverized coal and air. Neglect of this precaution has caused the loss of many lives and the destruction of much property. The present practice endeavors to keep the pulverized coal from mixing with air so that if it should happen to catch fire it would burn slowly without producing disastrous explosions.

Storage capacity for pulverized coal, because of the element of danger, should be as small as possible consistent with the continuous operation of the mill. It is customary to provide a bin for each kiln with a capacity of from 6 to 10 hours of operation. Such bins are usually situated 15 to 20 feet from the lower end of the kilns where they do not interfere with the operation. Each bin is supplied by a conveyer leading from the pulverizing machine.

Powdered coal is fed from the bottom of the bin by adjustable feeding arrangements generally consisting of a double-threaded screw conveyer having a variable feed. The coal dust is blown into the kiln by a jet of air with an injector. These injectors are arranged to deliver the dust axially to the kiln. Practice has proved that it is unnecessary to use more than one jet to a kiln.

For Steam Making.—There have been three broad kinds of apparatus produced to burn pulverized coal under boilers, viz.: The Pinther apparatus, Fig. 4, where the prepared coal is emptied into a hopper above a feed controlling mechanism and carried into the furnace by the natural draft; the Schwartzkopff apparatus, Fig. 5, having a mechanical feed, such as the revolving brush; and that arrangement in which the coal is blown into the furnace, as in the Day, or Ideal, apparatus, Fig. 6.

With the first type, efficiencies from 75 to 80 per cent. were obtained, but the capacity was limited. When sufficient draft was applied to introduce a considerable amount of fuel, the velocity was such as to carry unconsumed particles of coal into the back connections and tubes. When fuel is introduced into such a furnace at a rate that will give the full capacity of the boiler, a particle will remain in the combustion of an ordinary furnace less than half a second.

The brush injector or the Schwartzkopff apparatus is placed at the furnace door and upon the grate is a thin fire composed of coal of about the size of hickory nuts. Enough of the coal failed to be consumed when in suspension to cause the failure of the scheme.

When it is suggested that an air blast be used to introduce the fuel, the apprehension of an excess of air is natural. The relative volumes of equal weights of coal and air are about 1:990, and since it would hardly be expected to use less than 15 pounds of air per pound of coal, the relative volumes of coal and air introduced would be $1:(990\times 15) = 1:14{,}850$.

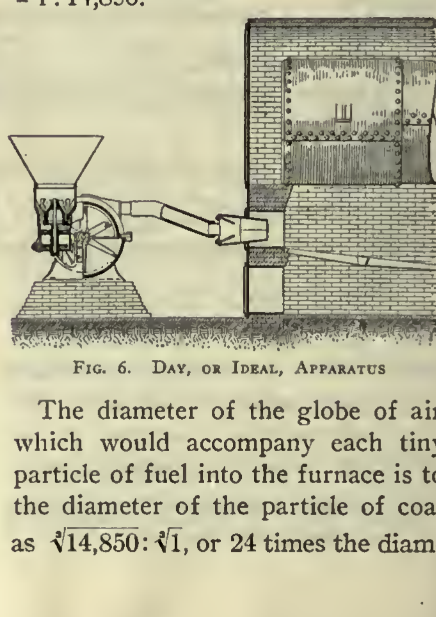


Fig. 6. Day, or Ideal, Apparatus

The diameter of the globe of air which would accompany each tiny particle of fuel into the furnace is to the diameter of the particle of coal as $\sqrt[3]{14{,}850}:\sqrt[3]{1}$, or 24 times the diam-

eter of the particle of coal; so it will be seen that plenty of air may be used for fuel injection purposes without exceeding the supply required for complete combustion. In all of the systems at present in use, the fuel is introduced in this way, the blower usually being so combined with the pulverizer that the pulverized coal is blown into the furnace as fast as it reaches the necessary degree of fineness.

In 1910, J. E. Blake, of the Blake Pulverizer Co., installed under a 300-horsepower water-tube boiler, at the Phipps power plant in Pittsburg, the arrangement shown in Fig. 7. The pulverizer served as its own blower, sending the pulverized fuel mixed with air to the furnace, where it was introduced by a series of nozzles extending across the width of the furnace. A little less than the rated horsepower of the boiler was obtained with an efficiency of about 79 per cent.

Claude Bettington, of Johannesburg, South Africa, where the price of coal is high, attacked the problem by designing a boiler especially for use with pulverized fuel. He took out his first patent in the United States, but his boiler was first commercially exploited in England. In his boiler the feed is upward, as shown in Fig. 8, through a water-jacketed nozzle in the center of a vertical furnace. The pulverizer acts as a blower, and the air supply is preheated. From the pulverizer the coal passes to a separator, where the larger particles settle out and return to be again treated, the finer passing on to the burner. The blast, about 2 inches, opposing gravity, tends to keep the coal in suspension, and as a particle would have to pass twice the length of the furnace (upward and downward) to escape, there is no difficulty in obtaining complete combustion.

The flame does not lift more than 10 per cent. under the highest rate of feed which it is practicable to employ, the temperature of the furnace and of the enveloping gases being increased enough to offset the greater velocity of ingress. The tubes of the inner row of the circular furnace are covered with a special refractory brick to within a short distance of the bottom header, making a brick-lined combustion chamber. The special bricks are placed loosely around the tubes, but soon become coated with molten ash and slag, which welds them into a solid wall, and closes the crevices between the lining and the top header. The ash which is not so slagged to the furnace surfaces, or carried out by the draft, drops into the ashpit below the lower header. The destructive effect of the impinging flame upon the brickwork is avoided by taking it upon the lower head of the central drum, or upon the accumulation of gas in the upper end of the chamber, the region of greatest heat intensity being in the core, while the tubes and shell are subjected to the lesser temperature of the somewhat cooled gases, which have not yet got away. The radiant heat is, however, effective upon them and the metal surfaces must be kept perfectly clean, and particular care taken as to the water level. One of these boilers having 2,606 square feet of heating surface has been running for over 4 years at the works of the builders. It evaporates regularly 14,000 pounds of water and has been worked up to 22,000 pounds of water per hour. These rates, however, (5.4 and 8.4 pounds per square foot of heating surface) are attained with stoker-fired boilers.

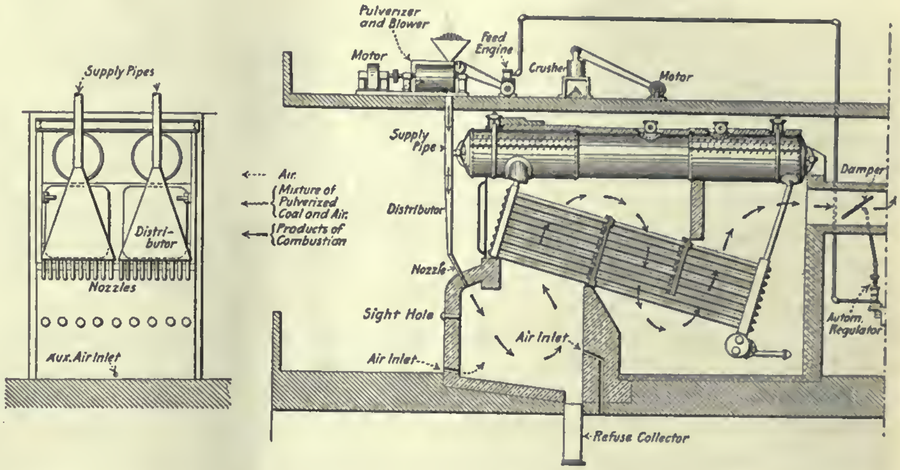


Fig. 7. Blake and Phipps Installation

It has been said that in spite of the cooling effect of the tubes the special bricks forming the furnace quickly burned away, and frequent renewals are necessary. Although this boiler will blow low-grade fuel successfully, and while under steam is easily managed, one fireman being able to look after several boilers, these advantages are largely offset in the opinion of some engineers by high cleaning and maintenance charges.

With the ordinary method of burning coal, the grate, with its bed of solid incandescent fuel more or less encumbered with ash and clinker, offers a considerable, varying, and uneven resistance to the passage of air, rejects the incombustible residuum with some difficulty and allows some of the unburned fuel to sift to the ashpit or to be fused in with the clinker. If the fuel can be burned in suspension, many of these difficulties disappear and the draft-producing apparatus is reduced to that which will remove the products of combustion and allow enough air to enter to burn the required amount of fuel. There still remains, however, the difficulty of getting rid of the incombustible. With 10 per cent. ash, there will be 200 pounds of refuse to remove with each ton of coal burned. If this is kept in a pulverized form it is carried into the back connection, the tubes, and stack, and scattered about the neighborhood. If it is fused it clings to the

surfaces of the furnace and aggregates into masses, occasioning damage to the brickwork in its removal and comparatively frequent stoppages for cleaning. In one instance the molten slag formed in sheets and ridges upon the sides and in stalactites upon the roof of the furnace, while the floor was covered with a plastic mass, which solidified when the furnace door was opened, and could hardly be removed without material damage to the furnace.

There have been several disastrous explosions of the prepared fuel outside of the furnace; but these can be prevented easily. Coal, however finely comminuted, does not contain the elements necessary for its own combustion, and if ignited will burn only slowly if kept in a compact mass. It is only when it is diffused in a cloud that the oxygen of the atmosphere can get to it quickly enough to make the rate of combustion dangerous. The pulverized fuel can be safely conveyed en masse in suitable holders, in screw conveyers, or even in cars and barrows, if care is taken that it shall not be blown or sifted about in a finely disseminated state. In those systems where the pipe back of the blower is filled with an explosive mixture of coal and air, the rate of flow must exceed that of the propagation of flame in such a mixture, and in shutting down the coal supply should be shut off first. The pulverized mass will run like water, so that the pitch of chutes, conveyers, etc., must be such as to provide against the flowing of their contents.

While anthracite dust can be used, it burns more slowly than coal having a higher percentage of volatiles, and must be very finely pulverized. For most systems, practically all of the coal should go through a screen having 100 meshes to the inch, and for coals having a small percentage of volatile matter or where very rapid combustion is imperative the coal is ground to a fineness which will permit the greater part of it to pass through a 200-to-the-inch sieve.

The cost of pulverizing and the large initial cost of the drying, pulverizing, conveying and feeding apparatus, together with the fact that coal of practically all grades can be burned with a tolerable degree of smokelessness in the cheaper apparatus in common use with a degree of efficiency which leaves little margin to cover the increased expenditure, have combined to restrict the use of pulverized coal for boiler purposes to special instances.

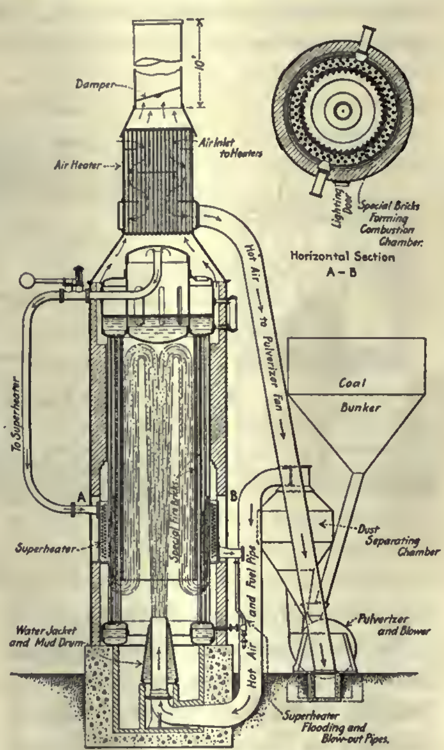


Fig. 8. Bettington Boiler

Mine Fires

*By A. C. Starr**

The causes of mine fires, which occur despite the best precautions, are numerous, but the primary reason is because the men employed are careless in that they do not adhere strictly to the mine laws or the careful instructions of their officers, or do not use common precaution when engaged in working hazardous places. In many instances, principally where the fire occurs in an abandoned section, there is never a satisfactory explanation given as to the origin of the fire, and it is laid to the hackneyed excuse of spontaneous combustion; but in my opinion a fire has rarely occurred that has not had the human element attached to it. Upon investigation we usually find that some man has gone through some old working place for his tools, or a boss has gone on a tour of inspection, and while the fire has sometimes been discovered days after such a trip, it seems to be a very logical deduction that the fire was started during such a visit. The man searching for his tools or the boss making the inspection has probably set fire to a leader of gas or his lamp has come in contact with some inflammable material.

The following are a few causes of fire in working places: A miner will frequently leave his lamp hanging on a timber and the draught will blow the flame back of the lagging, under the bark; or he may throw an old wick into some dry timber or into the loose coal. Perhaps when quitting his work at night he may leave loose carbide in a box. The action of the dampness on this carbide will generate enough heat to start a fire. In a place that is not properly ventilated, where there is a leader giving off gas intermittently, he may, just before going home, fire a shot which will back fire and ignite this gas. A miner, while making his cartridge or fixing his dynamite, may have an explosion. He may be smoking, and as a majority of men smoke pipes, he may knock some ashes into the gob. In the old-fashioned wooden pump and engine houses and stables, where the men have hung their oil-soaked clothes containing matches, the rats may nibble these matches, and in this way start fires.

The majority of the above cited causes of fires appear extremely trivial, but they are actual causes of some of our most serious mine fires, and I think sustain my statement regarding the human element.

*Superintendent Katherine Colliery, Shamokin. From a paper delivered before the Mining Society of Pennsylvania State College, October 15, 1914.

One per cent. of the contents of the oceans would cover all the land areas of the globe to a depth of 290 feet.

Fig. 1. Virginian Power Co.'s Plant at Cabin Creek Junction, W. Va.

Operations in the New River Field

The Scarbro and Dunloop Mines of the New River Company, in Fayette County, West Virginia

By William Z. Price

THE electrification of coal mines with possibly the greatest efficiency is in evidence in that part of the New River field of West Virginia now being developed by the New River Co..

At each of the 14 mines of this company the dismantling of the steam power plants may be witnessed. Even at mines where steam engines were driving the generators, the boiler plants are in disuse. Fig. 9 shows such a plant now abandoned.

Instead of following the scheme commonly adopted among many bituminous operators, that is, of establishing a central power plant, the company buys its power from the Virginian Power Co., whose plant is situated at Cabin Creek Junction along the main line of the Chesapeake & Ohio Railroad.

Power is transmitted at 44,000 volts for 25 miles over the mountains, Fig. 5, to Scarbro, where a large receiving frame is erected. At this frame, Fig. 2, some of the current is transformed to 2,300 volts and goes to the Scarbro and Carlisle substations. The rest goes to the other mines at its initial voltage and is there transformed to 2,300 volts.

At this voltage, the current enters the substations and passes into the choke coils, thence to the main incoming switch and then to the busbars of each panel, where an oil switch controls each circuit. Each panel is therefore a unit in itself.

In the background of Fig. 2 is seen the "trolley frame" above the sheave wheels at the tipple. This frame is described on another page of this issue.

There are 11 substations, each completely equipped. These house 21 Westinghouse motor-generator sets. Four of the stations have three sets, two of them have two, and the remaining ones have one each.

Take, for example, the Scarbro substation, Fig. 4. The use of three motor-generator sets gives high efficiency, since it permits each set to operate at its most efficient load. In the morning one set only is running; as the cars and locomotives begin work the load increases and another set is started; by noon when all the coal cutting machines, locomotives, etc., are in operation the load is the greatest and the three sets are running. As the day closes the load decreases and gradually two of the sets are stopped.

The shaft at Scarbro is 442 feet deep and the hoisting is accom-

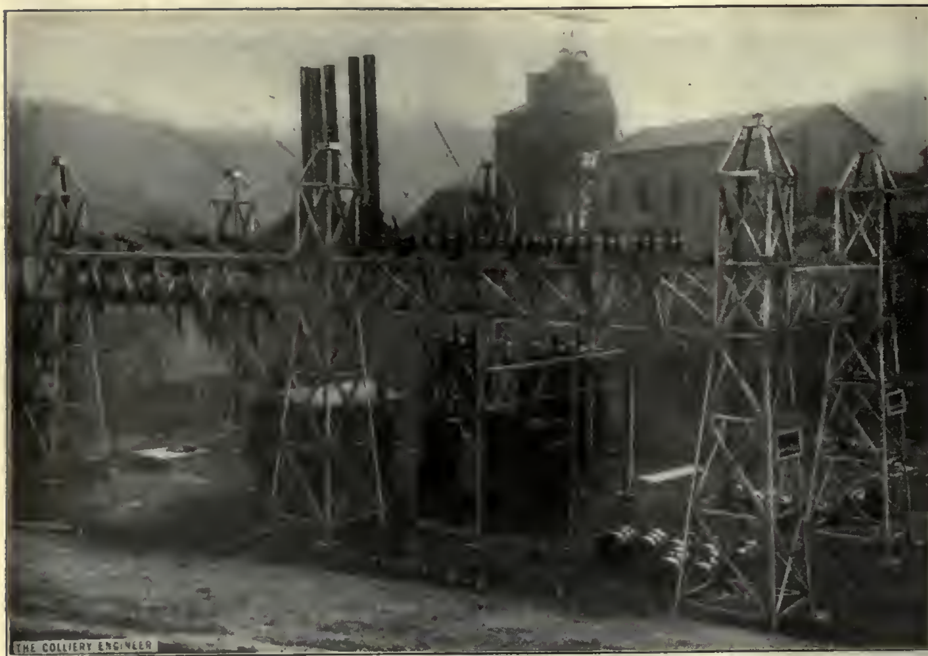


Fig. 2. Metering Frame at Scarbro. Tipple in Distance

plished by means of a Vulcan electric hoist. This hoist, shown in Fig. 8, and which may also be seen in the background in Fig. 4, consists of two conical drums, whose diameters are from 6 feet to 9 feet and has a rope speed of 1,700 feet per minute. The drums have a capacity of 483 feet of rope each, and the equipment can hoist two cars per minute. The coal in each car weighs about 3,300 pounds, each car 2,100 pounds and the cage 4,500 pounds, making a total weight of 9,900 pounds or almost 5 tons on the rope, each time coal is hoisted.

Two auxiliary brakes are attached; one is a hand brake and the other, which is mounted on the pinion shaft, is mechanically operated. The main service brake and the pinion brake are each applied by weights, actuated by air supplied by an independent motor-driven compressor. The main brake is of, what is called, the compensated or floating-lever type.

The motor is a General Electric three-phase, 60-cycle, 2,300-volt motor of 400-horsepower and runs at 585 revolutions per minute at full load. The speed, however, is controlled by cutting resistance into and out of the rotor circuit. Cast-iron grids are used for resistance, they are short-circuited by contactors operating from the master controller. The motor is connected to the pinion shaft by a flexible coupling. All the gears are of the single-reduction, machine-cut herring-bone type and are protected with guards.

An interesting feature of the hoist is its overwinding device. This consists of a gear limit switch *a*, Fig. 8, working in connection with a brake solenoid. In case of overwinding, the traveling nut in the device actuates the limit switch which cuts the power from the brake solenoid *b*, and the brakes are applied. This prevents overtravel in either direction. The hoist cannot start upon the return of power if the control should be carelessly left in "on" position. There is an automatic adjustment of the hoist control if it is ever desired to hoist from different levels. When the main brake becomes loose, the position of the vertical arm *c* is lowered. This may continue as long as the brake is loose until the arm gets so low that a small angle iron attached to it strikes the lever *d* and the power is shut off. Then, before the hoist can be started, it is necessary to tighten the brake. This is accomplished by the turnbuckle *e*. At the Cranberry, Whipple, and Carlisle mines are hoists of similar description.

Pumping at the New River mines is done entirely at night. This keeps down the day load. All the main sumps underground are of 24-hour capacity. At the various mines, the company has installed eight 600-gallon and five 150-gallon plunger pumps, together with four 600-gallon centrifugal pumps.

At the Dunloop mine near Macdonald, W. Va., is a new tipple built by Fairbanks, Morse & Co. Unlike the big Link-Belt tipple at Scarbro, the one at Dunloop is not built of steel but of white oak timber. It covers three railroad tracks and has a capacity sufficient to handle 250 tons of run-of-mine coal per hour.

The coal coming from the mines in 1½-ton cars is dumped over a Phillips cross-over dump into the receiving hopper which has a capacity of 6 tons. A beaded flight

Fig. 3. Tipple at Dunloop Mine

loader conveys the coal from the hopper to a pan conveyer. The latter consists of ¼-inch steel pans 38 inches wide, each of which is attached to two strands of steel roller chain. From the conveyer the coal is delivered to the shaking screens which are of all-steel construction, 5 feet wide by 16 feet long, with perforated steel screen plates.

Lump coal is made over 3½" × 5½" perforations; egg coal over 1¼" × 2½" perforations.

Coal loaded on two of the tracks is delivered to cars by means of beaded flight car loaders; one for each track. These loaders are so arranged that approximately 12 feet of the loader is horizontal and to this part the coal is delivered directly from the shaking screens. At the end of this horizontal run the 26-foot adjustable boom is pivoted. The booms are so arranged that they may be raised and lowered by an electric hoisting crab. In no case is the drop of the coal from loader to the car more than 18 inches.

The machinery in this tipple is so arranged that the following loading methods may be employed:

First: Screening lump and egg coal, which may be loaded into cars by means of the loaders on tracks Nos. 1 and 2; the slack going direct to car on track No. 3.

Second: Loading run-of-mine coal direct into car by means of loader on track No. 2.

Third: Loading run-of-mine coal direct to cars on track No. 3.

A 60-horsepower Fairbanks-Morse motor drives the beaded flight loader, pan conveyer, and shaking screens; and a 10-horsepower motor drives the two loading conveyers. Each of the hoisting crabs for elevating and lowering the hoisting booms on the conveyer car loaders is operated by a 3½-horsepower Fairbanks-Morse reversing crane motor.

In designing the tipple, care was taken to prevent breakage of coal. Stationary bars are provided at the discharge end of the loader from the receiving hopper through which the slack is discharged to the pan conveyer below, which in turn forms a cushion for the larger lumps to fall on, thus reducing breakage at this point. Stationary screen bars are also provided at the discharge end of the pan conveyer to relieve the shaking screens.

Fig. 4. Interior Scarbro Substation. Vulcan Hoist in Background

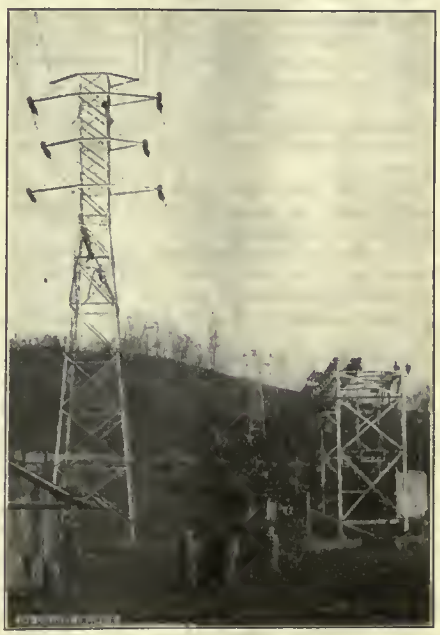


Fig. 5. Main Electric Transmission Line

The coal at Dunloop is soft and easily broken and that shipped from the tipple is about 50 to 55 per cent. slack, the balance being about equally divided between lump and egg. Tests made at the tipple show that there is not more than 2 per cent. of nut and slack in the egg coal, which is considered very clean considering the friability of the coal. The egg coal is screened up to the point at which it is discharged to the car loader. Lump coal is practically free from egg and smaller sizes. No nut coal is prepared at the tipple; the nut and slack going together as slack.

Throughout the district the coal shows a heating value of almost 15,000 B. T. U. In spite of its friability, which increases the breakage caused by handling, it is considered a high-grade steaming coal and rates as smokeless. An average analysis shows the following composition: Moisture, 3.77; volatile matter, 21.00; fixed carbon, 72.46; ash, 2.77; sulphur, .55.

The company has promulgated a set of mining rules which apply to all the operations. Each rule has a certain weight, depending on its importance. After the inspection of the equipment by the company inspector, each mine is rated according to its condition as required by the rules. The number given at the

end of each rule shows the relative weight of each rule in rating. They are as follows:

Rules and Instructions Governing the Operation of the Mines of the New River Co.

These rules and instructions are intended to supplement the mine law and

Fig. 6. C. & O. Ry. Geared Locomotive

the posted rules of the company. Should anything in them conflict with the mine law or the rules, the law and the rules must govern and be followed explicitly.

S. A. Scott, General Manager

TIPPLE AND OUTBUILDINGS

1. Tipple must be kept free from all accumulation of coal, slate, oil, or any other refuse. 2.

2. Not less than four (4) barrels with two casting pails to each barrel must be ready for immediate service in the tipple. Barrels to be kept full of water with one (1) peck of salt dissolved in each barrel. Pail shall be of round bottom type, and located in a convenient place to barrels. 5.

3. Where pit cars are greased on the tipple, waste oil must be cleaned up daily. 2.

4. Machinery operating the tipple must be kept properly oiled and protected from dust and slack. 2.

5. Tracks under and below the tipple must be kept clean and free from bone and slate or any other refuse that may have been picked or fallen from cars. 2.

6. See that all cars are thoroughly cleaned and doors properly fastened before loading. Any cars having doors that cannot be securely fastened must not be loaded. 2.

7. Cars must be properly loaded and neatly trimmed, and must be free from bone and slate. 2.

8. Surface landings must be kept clear of all material. Do not pile posts, rail, or other supplies at the top of the shaft, except such material that is ready to be sent into the mine. 2.

9. A board must be located at a convenient place near the top of the shaft or near the drift mouth on which the pit boss can show what supplies he wants that day. 2.

10. The blacksmith shop must be kept in a neat and clean condition at all times. 2.

11. Stock of iron and steel must be properly racked; bolts and nuts must be kept in boxes fastened on the wall for that purpose and plainly marked, showing sizes. 2.

12. Not over four (4) per cent. of the total number of pit cars will be allowed on the shop track at any one time; the remaining ninety-six (96) per cent. must be in good state of repair. 25.

13. Scrap iron must be deposited in a scrap pile and no scrap will be allowed to remain scattered about the plant. Scrap copper and brass must be kept under lock and key. 2.

14. All buildings must be properly maintained; roof, doors, windows, etc., shall be kept in good state of repair at all times. 2.

15. Allow no collection of debris around any building or at any point on the property. 2.

16. Garbage boxes shall be placed at frequent intervals throughout the camp and cleaned regularly. Boxes shall be built 4 ft. x 4 ft. x 6 ft. with hinged sides. 3.

17. All dwellings, including fences and outhouses, must be kept in good state of repair at all times. 2.

18. Wiring of buildings and dwellings to be in accordance with Underwriters' Rules on wiring. 2.

19. Vacant dwellings must be securely locked at once; if for any length of time, the windows must be boarded over. 2.

20. Special attention must be paid to water lines; they must be kept open and protected from freezing. Only self-closing hydrants shall be used. 2.

SUPPLIES AND GENERAL OUTSIDE

21. All supplies must be kept in places built for that purpose. 2.

22. Posts, rails, ties, and steel rail must be neatly piled or racked in convenient places. 2.

23. All electrical supplies must be kept under lock and key and under the direction of the machine boss. 2.

24. Fish-plates, fish-plate bolts and spikes must be kept in supply house. 2.

25. Building material; such as, windows, doors, roofing, and lumber, must be kept in supply house. 2.

26. Pit-car lumber must be carefully piled under cover so that it will not become misshapen. 2.

27. Pit-car wheels, axles, and boxings must be kept under cover in a convenient place to the repair shop. 2.

28. Pit-car, engine, cylinder, and machine oil shall be kept on racks in the oil house with drip pans in order to minimize waste. 2.

29. All gearings, belts, pulleys, and wires must be guarded so as to prevent accident to employes. 10.

30. In a convenient place in the engine house have for emergency use 2 stretchers, 2 waterproof and 2 woolen blankets, 1 gallon of linseed oil, and first-aid cabinet. 2.

31. Mines shall start dumping at 7:30 and all day men must work 9 hours at their working places.

32. Strict attention must be paid to all rules and notices posted about the property.

HOIST SHAFT AND AIR-SHAFT

33. Hoist shaft shall be examined after each shift and written reports made in shaft report book showing condition of guides, buntons, etc. This report book should be kept with the fire boss' report book. 15.

34. Each working day, immediately after 12 o'clock, noon, the cages, safety catches, ropes, sheaves, bearings, etc., must be examined by the blacksmith and condition reported to the superintendent or outside foreman. 15.

35. Hoisting ropes must be resocketed at least once every 2 months, and a record showing date ropes were renewed and the dates they were resocketed shall be posted in the engine room on form provided for that purpose. 15.

36. Air-shaft to be examined and hoist engine for same run once every week, and report of examination shall be kept in regular shaft report book. 25.

37. Foot of air-shaft must be kept clear of slate, timber, or other refuse at all times. 15.

38. Safety gates in the tipple and surface landing to be kept in proper working order at all times. .05.

39. Water rings in both shafts shall be kept free from mud and refuse, and pipes draining to the lodgment or shaft bottom must be kept open. .05.

VENTILATION AND EXAMINATION

40. All overcast shall be built of masonry or concrete. 10.

41. All permanent stoppings shall be built of concrete or masonry. If they are built of mine rock, the same shall be 18 inches thick laid in rich cement mortar; if of brick, wall must be two bricks thick laid in cement mortar, and, if concrete, wall shall not be less than 9 inches thick. 10.

42. Stoppings on butt entries can be made of a dry wall faced up with a rich mixture of cement mortar, or a wall one brick thick or 6 inches of concrete; if dry wall construction is used, stoppings should not be less than 4 feet in thickness. 10.

43. All permanent mine doors shall be substantially built; the side walls shall be built of either brick or rock laid in rich cement or concrete. No canvas doors are to be used. 10.

Fig. 7. Saw Mill in New River Region

44. All old workings must be examined at least once every week, unless otherwise directed by the company's inspector. 10.

45. Have check-curtains placed on the entries to deflect air into rooms; these curtains are to be placed not less than every sixth room. When check-curtain is hung between two rooms, all the break-

throughs between those rooms shall be closed, except the one nearest the face. 10.

46. There must be not less than 8,000 cubic feet of air passing through the last breakthrough on each entry, whether working or not. 10.

47. The fan, at mines where fire bosses are employed, must run continuously day and night, except when necessary to stop the same for repairs.

48. All places driving toward abandoned workings must be protected with bore holes drilled not less than 12 feet in advance; also diagonal holes drilled not less than 12 feet deep at 8-foot intervals along the rib.

49. All abandoned workings are to be properly fenced off. 10.

50. All haulage roads and working places, as far as practical, shall be well drained. 10.

51. A recording pressure gauge and a U gauge shall be placed on the fan at every mine where fire bosses are employed. 10.

52. The mine foreman shall visit each working place each alternate day, and every day where necessary.

53. The fire boss, before starting on his morning examination, shall see that the fan is running at the proper speed, examine the water gauge, and see that the air is entering on its proper course. Examination must cover all working places, including falls adjacent to working places.

54. After the fire boss has made his morning examination, he shall reenter his section and examine every working place, excepting days he is examining old workings.

55. On his second examination he is to see that the places are on line and carry tools so that he can make the necessary repairs to brattice, and he shall give particular attention to posting. 10.

56. If the fan has been stopped one-half hour or more for any cause whatever, the mine must be reexamined before allowing the men to enter. This applies to mines where fire bosses are employed. 10.

57. Designate the speed that the fan is to run, and post a notice in the fan house to the effect that it is to run at that speed. .05.

58. In hanging canvas, a board 1 in. × 6 in. must be used next the roof and canvas nailed securely to the same, and make it as air-tight as possible. Sufficient room must be left behind the brattice for ventilation. 10.

59. The mine foreman must show on mine print by darts or arrows the direction of the air-currents.

60. The superintendent shall have exhibited in his office the ventilation print last received from the engineering department; also 100-foot working print. When last print is received, the old one must be destroyed.

61. When designated by company's inspector, working places shall be examined at the end of each day's shift to see that no fire is left.

62. Air-courses must be kept clean and examined frequently. 10.

63. No cars shall be left standing in the airways where they will retard the ventilation. 10.

WORKING PLACES

64. All rooms must be properly posted. Mine foreman and fire bosses must be furnished with posting plans, and must exhibit same when requested by company inspector. 15.

65. Positively no slack, fine coal, or dust will be allowed to remain in the working places, along the roadway or in the gob. 25.

66. All breakthroughs in rooms and entries must be the proper distance apart, and, when a place is completed or stopped for any cause, a breakthrough must be cut at the face. 10.

67. Turn no rooms in advance of the air-currents, unless just to neck the room. 10.

68. Drive all main entries 10 feet wide, and load slate out clean from rib to rib. 10.

69. All dry and dusty places must be kept damp. 25.

70. When driving butt entries where necessary to leave the slate, pockets must be made and slate walled up in such a manner that it will be flush with the rib, and entries must not be over 11 feet wide. 20.

71. Pillars must be drawn in such a manner that the faces will not be over 15 or 20 feet in advance of each other, fixing the breakline at the proper angle. Where it is necessary to slab pillars preparatory to robbing, the slab must not exceed the required width for the roadway. 25.

72. The mine foreman must see that the proper amount of timber is sent to each miner so that he can safely perform his duty. 10.

73. Drive all rooms the specified width. 15.

74. Room necks shall be 24 feet long and not exceed 10 feet wide. 15.

75. Rooms are not to be turned from each of a pair of entries at the same time, but are to be driven so that one side will be advancing and the other retreating. .05.

76. Carry a continuous chalk line for sight line in all places. .05.

EXPLOSIVES AND SHOOTING

77. Where fire bosses are employed, all shot holes shall be tamped with clay their full length; no short fuses allowed. No short fuses are allowed in any mine. 15.

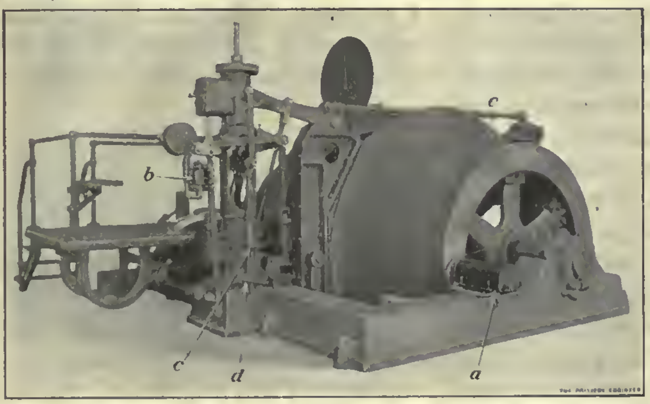


FIG. 8. VULCAN ELECTRIC HOIST

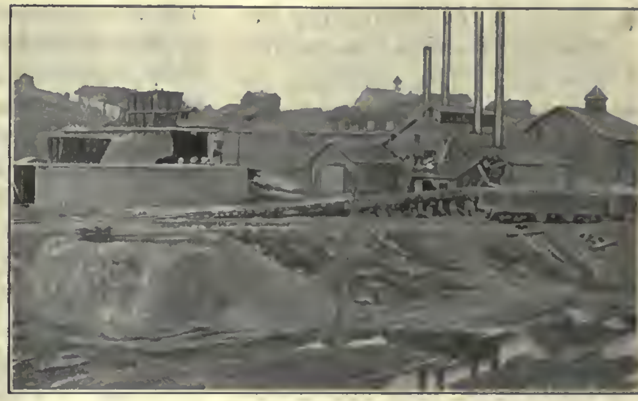


FIG. 9. NEW FAN AND DISUSED BOILER HOUSE

78. All miners are to give warning to men in adjoining rooms before shooting. 15.

79. No shot hole is to be drilled on the solid; and no more than one shot is to be fired at one time in any one place. 15.

80. Nothing but permissible explosives shall be used in gaseous mines. 15.

81. No shot holes that have missed fire are to be drilled out, but a new hole is to be drilled and charged lightly not less than 2 feet from the old hole. When a shot has missed fire, the workman must notify the mine foreman before entering his place. 15.

82. When shots are fired electrically, they must be fired by battery and not from electric or trolley wire. Miners must keep caps separate from explosives 25 feet in a hole dug in the rib. 15.

HAULAGE

83. Care must be taken in laying 16-pound as well as 40-pound iron; spacing of ties must not exceed 24 inches. Rail must be spiked as shown on plan of spiking. Mine foreman and roadmen will be furnished with plans and present them when requested by the company inspector. 40-pound iron will be laid on all main haulways as the entry advances, unless grading is necessary, when 20-pound iron will be laid over that portion to be graded. 25.

84. All track must be laid to grade when grade is given, and all track must be surfaced and laid to line. 10.

85. There must be at least 2½ feet clearance between the car and the rib on the room side of all new entries to allow the driver to pass the trip in safety, and this shall be kept clean at all times. 35.

86. All haulage roads must be cleaned, where practical, to give 3½ feet on one side and 2 feet on the other from the rail. 35.

(Continued on Page 574)

Metallic Iron in Coke Samples

Iron From Pulverizing or Grinding Apparatus Often the Cause of Discrepancy Between Actual and Theoretical Coke Ash

By J. R. Campbell*

RECENTLY our attention was called to the discrepancy between the actual and theoretical coke ash. The difference, in most cases, was over 1 per cent., the actual ash being always higher. Investigation showed that the cause of the discrepancy was the metallic iron in the powdered coke sample which came from the pulverizing or grinding apparatus.

The subject is not new, having been thrashed over and over a good many times in the past, but, in this case, the point of attack is different, and it seemed worth while to call it to the attention of both the chemical profession and the coke operators. Formerly, a good many chemists have used the magnet to remove metallic iron from the powdered coke sample. We have always looked upon this as a most pernicious practice, and one to be condemned, for the magnet not only removes the metallic iron produced by the grinding apparatus but also the inherent magnetic sulphide of iron, thus vitiating the sulphur as well as the ash content.

At the outset, we wish to point out that the data in this article is more or less a compilation, and we hereby give credit, where credit is due, to those who may recognize the results of their own investigations. We are particularly indebted to Mr. J. B. Morrow, of the Stag Cañon Fuel Co., Dawson, N. Mex., for the detailed method of determining iron in powdered coke samples as used in our investigation, though we understand it has been published before in various chemical journals.

The chief source of the inherent iron in coke is the pyrites in the coal. The free iron is probably caused by the grinding machinery. The action of heat on iron disulphide (pyrites or marcasite), is as follows: $7FeS_2 + \text{heat} = Fe_7S_8 + 6S$. Fe_7S_8 is pyrrhotite or magnetic sulphide of iron. To demonstrate this is simple. If the ordinary sulphur ball found in coal is powdered and the volatile matter determined, according to the standard method, it will be found that the loss in sulphur corresponds pretty well to the theoretical, and the residue is strongly magnetic, even with the ordinary hand magnet. We have taken the ignited powdered pyrites, put it in a pile, and then, by means of the magnet, removed the whole of it to another place.

In the reaction cited above, the loss of sulphur is 42.8 per cent., which may be reasonably expected to be volatilized in the coking process. In ovens of the beehive type, where approximately 1½ tons of coal make 1 ton of coke, there will be a volatilization of about 21½ per cent. sulphur. Roughly speaking, the average coke man figures 50 per cent. loss in sulphur in burning coal, or an ultimate volatilization of 25 per cent. sulphur from coal to coke, based on the following reaction: $FeS_2 + \text{heat} = FeS + S$, which is not strictly correct. This side discussion on the subject of sulphur is outside the scope of the article, but it comes in naturally, so is mentioned.

The discrepancy between the actual and theoretical ash in coke is shown in Table 1, which is an average at three coke plants.

In this tabulation it will be noted that one plant showed ash in the actual coke to be almost 2 per cent. higher than the theoretical, which is a very serious matter as regards blast-furnace practice. The other two plants showed a trifle over 1 per cent. higher ash in the actual coke than in the theoretical. It will be readily seen by the experienced furnace man how the burdening of the furnace will be affected. He will be figuring extra limestone when it is not needed at all.

Table 1

	Plant A Per Cent.	Plant B Per Cent.	Plant C Per Cent.
Ash in coal	7.32	8.83	6.88
Per cent. total coke	73.70	81.00	82.00
Ash in coke	11.87	12.01	9.42
Calculated ash in coke	9.93	10.90	8.39
Difference	1.94	1.11	1.03

The method of determining the metallic iron in powdered coke samples in this investigation is known as the copper sulphate method, and the details are as follows:

Five grams of the powdered coke sample are weighed out into a No. 2 beaker and 75 cubic centimeters of a 2-per-cent. solution of C. P. copper sulphate added, after which the whole is boiled for 10 minutes, filtered and washed. The filtrate is acidified with HCl, oxidized with HNO_3, precipitated with NH_4OH, filtered and washed. As a safeguard, the precipitate is dissolved and reprecipitated in order to free it entirely from copper salts. The final precipitate is then dissolved in HCl, the iron determined by the potassium permanganate or potassium bichromate method and calculated to Fe_2O_3, since it burns to the oxide. The Fe_2O_3 is deducted from the ash and the difference divided by the quantity of coke minus the metallic iron found, which gives the true ash content.

Some detailed examples of executing the determination are as follows:

* Chief chemist, H. C. Frick Coke Co.

Sample A, Coke, January 22, 1915 (40 Mesh)

Ash reported (apparent), 12.22 per cent.
Sulphur, 1.206 per cent.
Fe by copper sulphate solution (5-grm. sample):
Titration with bichromate

44.0 cc.
41.8
2.2 cc. = .022 grm. *Fe* or .0314 grm. Fe_2O_3
.1222 grm. ash
5
.6110
.0314
.5796
5.000 grm. coke + *Fe*
.022
4.978).5796000(.1164 = 11.64% true ash
12.22%
11.64
.58
.7
.406% *Fe* from grinding apparatus

Sample B, Coke, January 23, 1915 (40 Mesh)

Ash reported (apparent), 9.22 per cent.
Sulphur, .680 per cent.
Fe by copper sulphate solution (5-grm. sample):
Titration with bichromate

41.1 cc.
39.2
1.9 cc. = .02 grm. *Fe* or .0271 grm. Fe_2O_3
.0922 grm. ash
5
.4610
.0271
.4339
5.000 grm. coke + *Fe*
.019
4.981).43390(.0871 = 8.71% true ash
9.22%
8.71
.51
.7
.357% *Fe* from grinding apparatus

In the above examples, the coke was powdered to a 40-mesh sieve only, the idea being to keep down abrasion as much as possible. The preliminary preparation was made on a Sturtevant roll jaw crusher, which crushed down to approximately ½ inch and under. The sample was quartered and finished on a chilled cast-iron bucking board, using the impact instead of the rubbing stroke. Yet, in spite of all precautions, the sample took up approximately .4 per cent. iron from the grinding apparatus. It will be further noted that the percentage of ash and sulphur has but little effect on the amount of metallic iron.

A collaborator reports further investigation as follows:

Sieve Test of Sample

All passed 80 mesh

	Per Cent.
Through 80 mesh on 100 mesh	= 56.13
Through 100 mesh on 250 mesh	= 25.35
Through 250 mesh	= 18.52

Apparent ash, 13.28 per cent. checked.

Free iron by copper sulphate on 5 grams coke:

	Per Cent. *Fe*
(1) Determination, 6.0 cc. bichromate	= 1.15
(2) Check, 7.0 cc. bichromate	= 1.45
(3) Check, 6.5 cc. bichromate	= 1.20
Average	1.26

Second sample was taken in the usual way, then passed through the Sturtevant breaker reduced to ½-inch size, then passed through Gates crusher so all passed a ¹⁄₁₆-inch sieve. Then for the purpose of determining the iron which was taken up in the subsequent pulverization of this sample, the coke from the Gates crusher was screened with a 40 mesh sieve and all that passed through the 40 mesh discarded; thus, whatever iron may have come from the preliminary grinding was discarded.

The sample remaining on the 40 mesh was then subdivided, one-half of same finished on the bucking board to pass a 60-mesh sieve:

(*a*) Sieve test showing

	Per Cent.
Through 60 mesh on 100 mesh	= 71.1
Through 100 mesh on 250 mesh	= 24.2
Through 250 mesh	= 4.7

Free iron by copper sulphate:

	Per Cent. *Fe*
5 grm. require 2.5 cc. bichromate	= .50
5 grm. require 1.6 cc. bichromate	= .32
5 grm. require 1.6 cc. bichromate	= .32

(*b*) The other half remaining on the 40-mesh screen was finished on a bucking board, all to pass 100-mesh sieve.

Sieve test as follows:

	Per Cent.
Through 100 mesh on 200 mesh	= 83.1
Through 200 mesh on 250 mesh	= 14.1
Through 250 mesh	= 2.8

Analysis—iron by copper sulphate:

	Per Cent. *Fe*
5 grm. require 5.0 cc. bichromate	= 1.00
5 grm. require 4.6 cc. bichromate	= .93
5 grm. require 5.7 cc. bichromate	= 1.14
Average	1.02

(*c*) A portion of (*a*) and (*b*) which remained on the 40-mesh sieve was taken and finished in a porcelain mortar to pass 80-mesh sieve:

Iron by copper sulphate:

	Per Cent. *Fe*
5 grm. sample required .1 cc. bichromate solution	= .02
5 grm. sample required .1 cc. bichromate solution	= .02
5 grm. sample required .1 cc. bichromate solution	= .02

(*d*) Another different sample of coke was taken and reduced in a porcelain mortar, not coming in contact with steel grinder in any process of the preparation.

Iron by copper sulphate:

	Per Cent. *Fe*
5 grm. require .1 cc. bichromate solution	= .02
5 grm. require .1 cc. bichromate solution	= .02

RÉSUMÉ

		Per Cent. *Fe*
	Sample finished by steel mill sampling equipment, all passing 80-mesh sieve	1.26
(*b*)	Sample finished on coke works bucking board after discarding the dust made by preliminary breaking, all passing 100-mesh sieve	1.02
(*a*)	Sample finished on coke works bucking board, all to pass 60-mesh sieve	.38
(*d*)	Sample ground in porcelain mortar	.02
(*e*)	Sample ground in porcelain mortar without coming in contact with steel crushers in any part of the preliminary crushing	.02

In the above, the Sturtevant pulverizing apparatus was employed in regular practice, i. e., roll jaw crusher, rolls, and finishing machine, with the exceptions noted. The finishing machine apparently puts a lot of iron in the powdered coke.

A second investigator makes the following report:

Blank for iron in the $CuSO_4$.
2).0015 wt.
.00075 wt. Fe_2O_3 for 75 cc. used.
24 hour sample coke for 2/13/15
5).0285 wt. Fe_2O_3
.0057
−.00075 blank
Check. .00495 Fe_2O_3 (1 grm.)
5).0292
.00584
−.00075 blank
.00509 wt. Fe_2O_3 (1 grm.)

Coke for the 16th
5).0335 wt. Fe_2O_3 (5 grm.)
.0067
−.00075
.00595

Apparent ash reported on this sample for 2/16/15 was 11.88 per cent.

.1188
5 grm.
.5940
.03275
.56125

.0335 wt. Fe_2O_3 on 5 grm.
.00075 blank
.03275 wt. Fe_2O_3 on 5 grm. cor. for blank
7 Fe_2O_3 to *Fe*
.022925 *Fe* on 5 grm.

5.000000
.022925
4.977075 actual coke

.56125 ÷ 4.977075 = 11.27+ true ash.

From this, it looks like a correction of about .6 per cent. when reducing to 60 mesh.

Two opposite quarters were taken from the above sample (coke for the 16th) after passing the rolls and through the 30 mesh, and then prepared in an agate mortar to 80 mesh. The copper sulphate test was made for iron, and gave as follows:

$$5)\underline{.0097}\quad \text{Wt. } Fe_2O_3$$
$$.00194$$

and calculating for the true ash on this sample gives 11.31+ against the apparent ash 11.34.

In the above, the preparation of the powdered sample is about as follows: The finishing machine was not used. The coarse sample was first put through the Sturtevant crusher and then through the rolls, mixed and quartered to ½ pound, then passed through a 30-mesh sieve, which required practically no crushing or rubbing on the plate. The sample was then mixed and quartered to an envelope amount and passed through a 60-mesh sieve, which required but three or four short rubbings.

This method of preparing the powdered sample apparently introduced about .6 per cent. extra ash into the coke sample. It will be noted that the preparation in the agate or porcelain mortar, as in the previous investigation, showed only traces of iron.

However, this investigator later reported that the iron in the powdered sample could be kept down to approximately .3 per cent. by extreme care in reducing the coke sample after passing the crusher and rolls, and employing 20-, 30-, 40-, and 60-mesh sieves, and by using a pounding stroke with the buffer, avoiding the rubbing stroke. By using a 40-mesh sieve instead of a 60 mesh, the apparent ash is only .1 per cent higher than the true ash, as determined by the copper sulphate method. The tests on the whole show that reducing to 60 mesh picks up about three times as much iron as when reducing to 40 mesh. Furthermore, the 40-mesh sieve was found satisfactory and adopted by this investigator.

Table 2, prepared by a third collaborator, is very illuminating.

Table 2

Coal		Furnace Coke					
Date, 1915	Per Cent. Ash	Date	Per Cent. Metallic *Fe* in Sample	Per Cent. Figured to Fe_2O_3	Actual Ash	True Ash	Theoretical Ash
January 31	10.62	February 1	.66	.93	11.91	11.05	12.92
February 1	8.76	February 2	.88	1.23	11.73	10.60	10.44
February 2	9.15	February 3	.64	.90	12.03	11.20	10.96
February 3	8.52	February 4	.72	1.01	12.13	11.20	10.12
Average	9.26	Average	.73	1.02	11.95	11.01	11.11

In the above table, the ash as obtained in the routine work, is called the actual ash, and the ash obtained after correcting for metallic iron, the true ash. The theoretical is figured in the usual manner from the coke yield. It will be noted that almost 1 per cent. of iron oxide, or approximately .7 per cent. iron was added from the grinding machinery, but, when correction was made, the theoretical and true ash agree close enough for all practical purposes. We find the agreement between the theoretical and true ash is very close in all cases where correction is made for iron on the apparent ash, or the result usually reported by the laboratory.

From the foregoing, the following comments are in order:

It is evident that powdered coke samples, when prepared in iron or steel grinding apparatus, take on metallic iron in proportions sufficiently large to vitiate the determination of ash, unless great precautions are taken. It is quite probable that the routine preparation of powdered coke samples in the average steel works or commercial laboratory is the cause of the ash showing appreciably higher in the coke than indicated by the theoretical, based on the coal ash. Therefore, it behooves the practical coke operator to be on the lookout when his coke is showing unusually high ash and complaints are coming in; the first thing he should do is to have a "heart to heart" talk with his chemist to see if the trouble does not lie in the laboratory. Corrections for 1 per cent. or 2 per cent. metallic iron will go a long way towards "clearing the atmosphere."

There is but one way to arrive at technical results, and that is to establish a blank to be deducted from the apparent ash just as it is done on the Eschka's mixture for the sulphur determination. The increment of ash must be determined by each chemist for himself, for it seems impracticable to get away from the use of iron grinding apparatus. He will have to make the most of a bad situation.

Metallic iron in powdered coke samples can be kept at the minimum by observing the following precautions:

First, crush the coarse sample in a jaw crusher, then pass to a set of rolls accurately adjusted to run true so that there is no rubbing or abrading action. The rolls ought to crush uniformly to 10–20 mesh without difficulty.

The laboratory sample may then be finished on a good hard bucking board, or in a special steel mortar, using the impact stroke instead of the rubbing or rocking motion usually employed.

The most important precaution of all is not to try make the powdered sample too fine. Long experience has taught us that a 40-mesh sample will give concordant results, and it is urged that all chemists investigate this for themselves. It saves labor and time all along the line—in the sampling house and in the laboratory.

By the use of alundum crucibles, the air permeates the 40-mesh coke through the sides and bottom, with the result that the sample is rapidly ashed. A 2-gram sample will burn to ash in approximately

1 hour in a good muffle furnace or over a Meker burner.

And last, but not least, for reasons already explained, never pass a magnet through a powdered coke sample to remove the iron. Use the copper sulphate method in determining the correction to be made to the coke ash.

Short Course in Coal Mining

The Illinois Miners and Mechanics Institute announces a short course in coal mining for coal mine employes begining June 7 and extending to July 17, 1915. The course is offered in cooperation with the Department of Mining Engineering at the University of Illinois. It should appeal to men who intend to become aspirants for certificates as state mine inspector, mine manager, etc. A number of men who attended this course last year were successful in such examinations. The total cost for the 6 weeks' course will probably be less than $50 for each man. There is no tuition, and the free textbooks of the Institute are used.

Surveying in Anthracite Mines

Part 2.—A Description of the Office Methods and Calculations of Work Described in Part 1

By William Z. Price

IN THE following article the transit notes, which appeared as Fig. 2 in Part 1, are shown completed in Fig. 5; and the side notes, Fig. 3, are reprinted to show their relation to the finished map.—Editor.]

In nearly every instance the corps that does the field work afterwards does the calculating and plotting in the office. This requires from two-thirds to three-fourths of the time spent in the mines and gives all members of the corps the best possible experience.

First of all, the horizontal and vertical distances must be calculated, since all measurements are taken "on the pitch." Gurden's Traverse Tables are used for this work. These tables give the natural functions of each minute of the arc from 0° to 90° for all distances from 1 foot to 100 feet. The horizontal and vertical distances are then recorded in ink in the first two columns on the right-hand page of transit notes (Fig. 6). The courses are calculated and put into the third column on the left-hand page of the transit notes. These are also recorded in ink so that there can be no error in reading them. In this manner the entire survey is recorded in the transit books.

Each slope, shaft, or drift has its own individual transit-notes and side-note books. This enables more than one corps to be working at the same colliery at the same time, it better classifies the work, and also enables one part of the mines to be worked up in the office while another part is being surveyed, if necessary. When this is done the traverse books (Fig. 7) are brought up to date. This is usually done by the transit man and his first

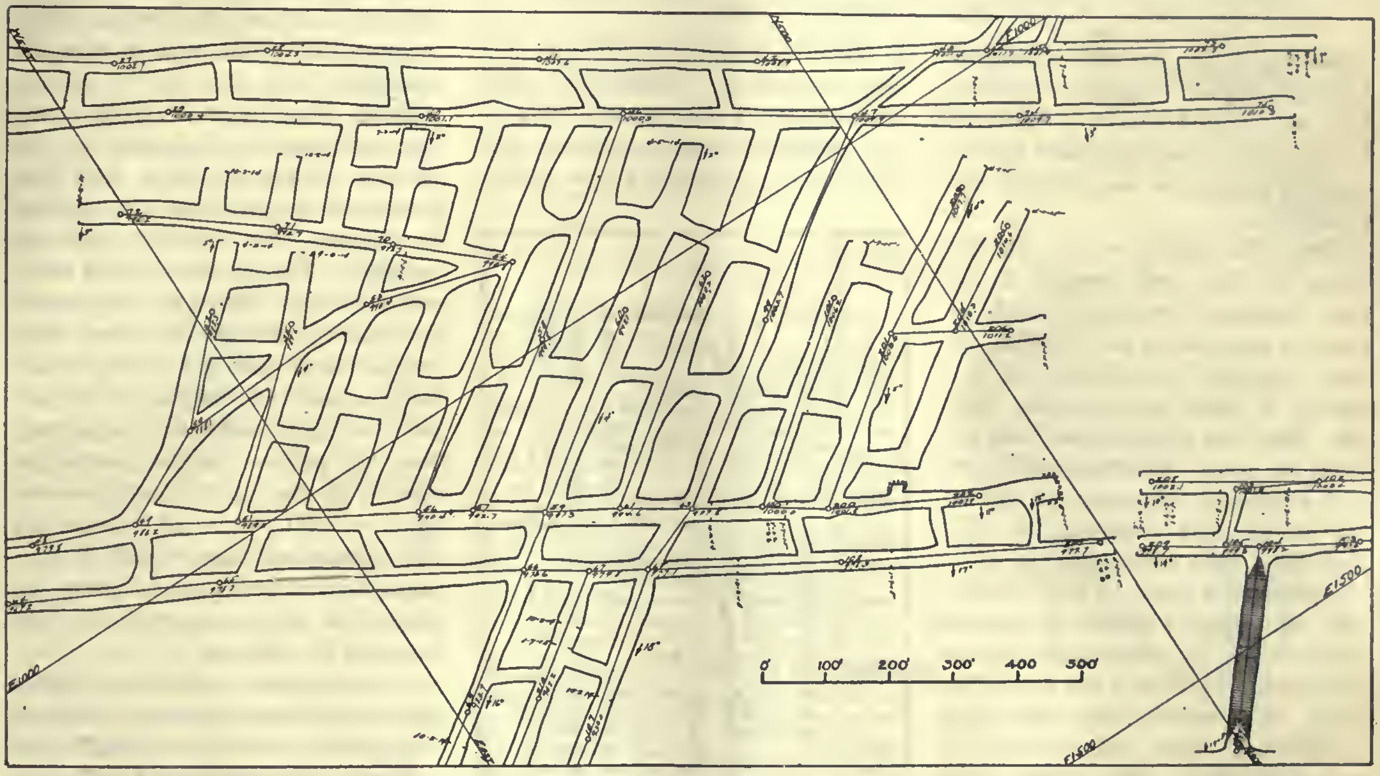


Fig. 5. Mine Map Showing Method of Plotting

44								45
	—Red Ash—				No. 37 Slope			
Carter, Richards, Fry, Cox & Dorak					—April—1—1915—			
75 100 – 200	212°40'	N32°40'E	+2°07'	48.91	206°05' 48.88	+1.81	L.T.6.04 L.T. 6.00	In Gwy
200 – 201	142°07'	N37°53'W	+5°04'	145.04	144.83	+7.76	B. 5.42	Up Cha.
200 – 202	207°15'	N27°15'E	−4.0 +1°05'	118.25	118.23	+6.23	L.T.6.09 B. 6.11	Face Gwy
200 201 – 203	148°26'	N31°34'W	+3.2 +5°11'	125.60	142°07' 125.09	+8.15	B. 5.73	Face Cha.
201 – 204	210°02'	N30°02'E	−0°27'	52.41	52.41	−0.36	L.R. 5.12	In Headg
204 – 205	149°01'	N30°59'W	+7°17'	92.08	91.34	+11.68	L.T. 7.21	Up Cha.
204 – 206	212°14'	N32°14'E	+0°18'	44.76	44.76	+0.74	L.T. 6.14	Face Hdg
76 108 – 207	208°16'	N28°16'E	+2°13'	204.15	210°05' 203.99	+7.85	L.T.6.28 B. 6.64	Face Awy

Fig. 6. Transit Notes With Office Computations

noteman. The stations, azimuths, vertical angles, courses, together with measured horizontal, roof, and vertical, distances, are copied therein and the elevations immediately calculated.

Since the elevations are carried along on the roof instead of the ever changing roadways, a roof-distance is essential at each station, for the "elevation" at each station in a survey is taken by measuring from the "spot" on the roadway and not from the roof. Referring to Fig. 6, and assuming the seam at station 100 to have an elevation of 1,000 feet above tide, that elevation is the elevation of a point on the roadway 6.04 feet directly below the station in the roof. By simple addition, the elevations of 200 and 201 are calculated. The transit notes show that a sight was taken from station 200 to station 202. This would ordinarily mean simple addition to find the elevation of the latter station; but for the present purpose, assume that the transit had to be picked up after taking a sight at station 201. On setting up the instrument again at 200 it is found that the spot has been moved or obliterated, thus necessitating a new spot. This is the condition that confronts the transitman on starting a new survey

50								
				Pt.B	105.0	8	10	
					70	11	9	
					40	12	9	
202	−4.0 118.25	6	6		9	13	8	
	88	6	6	204				
	80	7	5	Stretch down Chamber				
	59	8	3		9		9	
	50	7	4	Pt.B	45.7		8	
	30	6	7		42	7	9	
	11	8	4		17	2	6	
200				Pt.A				
				Stretch in Heading				
201	145.04	9	11					
	130	12	13	204	52.41			
	110	11	10		43		9	
	90	12	11		42	9	7	
	79	13	7		27	7	8	
	70	14	9		12	7	10	
	52	8	15	201				
Pt.A	46				34	11	10	
	42	10	14	203	+3.2 125.60	12	12	
	20	12	9		90	11	13	4°
	6	8	11		70	12	12	
200					45	12	11	
					30	14	11	
200	48.91		7		10	11	12	
	40	7	6	201				
	28	4	8					
	20	7	9		61	11	7	Faulty
100					42	10	6	32°
					29	9	5	15°
Richards & Fry				202	Lined			
April-1-1915				200				

THE COLLIERY ENGINEER

Fig. 3. Side Notes

from an old station. The new roof distance is, say 6.09, the spot having been set slightly lower than the previous one. Then to get the correct elevation of the new spot add 6.00 (the old roof distance) to 1,001.81 (the elevation of the former spot), and it gives the elevation of the station in the roof, which is always constant; subtract 6.09 feet, the new roof distance, and the result is 1,001.72, the new elevation. In the case of station 201 it will be noted that the roof distance remains the same owing to the spot remaining intact. This is commonly the case in a continuous survey, hence the elevation is the same as was calculated at first.

From the courses which have been calculated and written in the traverse book, together with the horizontal distances, we are enabled to compute the latitudes and departures. This is done for all roadways, tunnels, slopes, etc., but never for rooms, due to the fact that rooms are of such short length and, being turned off gangways, the calculation of latitudes and departures for room stations is not deemed essential, so they are plotted by means of a protractor. In all cases every calculation and computation is thoroughly checked before being recorded in the traverse books preparatory to plotting.

The maps are laid off in 500-foot squares for coordination. After all coordinate stations are plotted and connected, the courses between them are checked by a protractor and the distances scaled. By this procedure any errors are quickly found and corrected. All room stations are then protracted from stations already in the rooms or from those

10

Volume and Page	Station	Azimeth	Vertical Angle	Measured Distance	Course	Horizontal Distance	Northing	Soothing	Total	Easting	Westing	Total	Roof Distance	Vertical Height	Elevation	Station
Volume 376																
Pg.72	100	212° 40'	+2° 07'	48.91	N32°40'E	48.88	41.15		N 287.05	26.39		E 1199.21	L.T. 6.04	+1.81	1000.00	100
	200	142° 07'	+5° 04'	145.04	N37°53'W	144.83			N 328.20			E 1225.60	L.T. 6.00	+7.76	1001.81	200
	201												B. 5.42		1009.57	201
	200	207° 15'	−4.0 +1° 05'	118.25	N27°15'E	118.23	105.11		N 328.20	54.15		E 1225.60	L.T. 6.09	+6.23	1001.72	200
	202								N 433.31			E 1279.75	B. 6.11		1007.95	202
	201	148° 26'	+5° 11'	125.60	N31°34'W	125.09							B. 5.42	+8.15	1009.57	201
	203												B. 5.73		1017.72	203

Fig. 7. General Style of Traverse Sheet

along roadways, as the case may be. The side notes are then drawn with the lines between the stations as guides. This is a simple task. The elevation of each station is shown under its number and it represents the elevation at L. T. or B. If it is L. R. in the survey .2′ is subtracted. Thus the map elevations show the floor of the seam.

The map, Fig. 5, shows the stations connected by fine lines. These indicate at a glance the course of the survey. When a survey is closed and tied the lines between the stations included in the tie are drawn on the map tracings. Otherwise, the stations on the tracings are not connected. This aids the transitman when in the mines, who by looking at his blueprint can see where he will find a tied survey in case he wishes to close his work with a known "tie."

In this respect it may be mentioned that the tied survey is accepted after the azimuth has closed within 0°03′ and the elevation less than a foot and the latitude and departures within two feet. In the latter case, however, it depends somewhat on the extent of the survey.

Individual tracings, showing the tie surveys, are made of each mine map and brought up to date each time a new tie is made. This is of great advantage in starting off new work as these tracings show clearly when tied surveys exist. No workings nor any station not tied are shown on these tracings. Ventilation tracings are also made showing the workings and all stoppings, overcasts, regulators, etc. No stations are shown on these tracings. By taking blueprints of these tracings to the mine, a member of the corps, usually the transitman, gets all the new information of such description after each quarterly survey or posting.

Each seam has its own individual map, and instead of having separate colors, all the work is put on in black. This facilitates tracing and makes the maps easier to read at any stage.

Numerous rules regarding maps may be cited, but the best are those which experience and the conditions of the case demand.

to the installation of a greater number of plants and to the advance in the price of gasoline.

The uses of natural-gas gasoline are many and varied. It is principally used for raising the standard of naphthas or low-grade distillates consumed in motors; it is also used for lighting; and it can be used like regular gasoline in all the arts. There is an ever increasing demand for this gas to be used in automobiles.

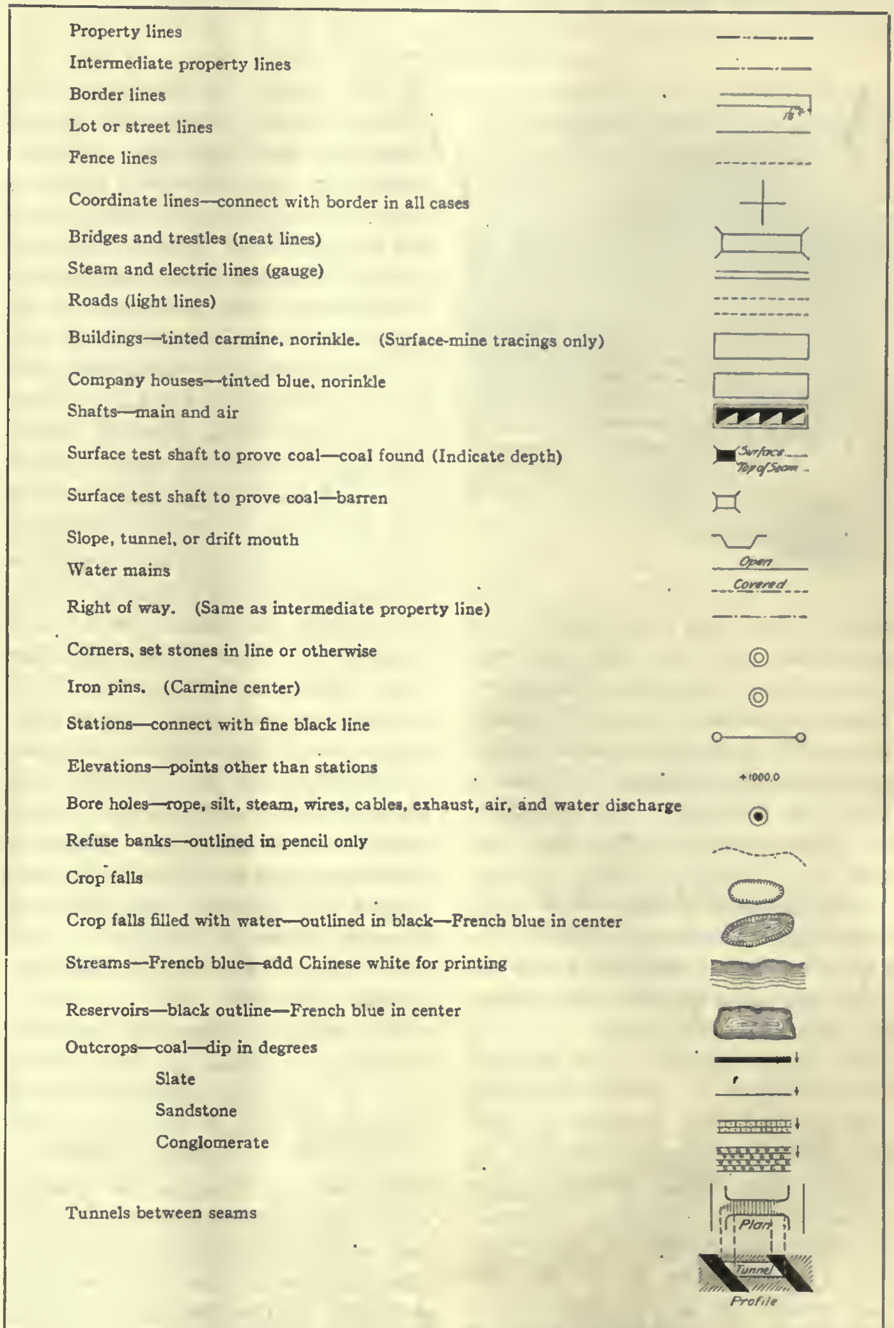


FIG. 8. CONVENTIONAL SIGNS FOR MAPS AND TRACINGS

Gasoline from Natural Gas

The extraction of gasoline from casing-head gas (natural gas from oil wells) has become one of the important adjuncts of the natural-gas industry in the United States. The production is increasing rapidly, the quantity produced in 1913 having almost doubled that of 1912, owing

Reversing Main Air-Currents

Experiences Showing the Importance of Having Means for Reversal. Method of Reversing Independent of Fan

*By William Clifford**

Although the writer has during the last 18 years provided means for the reversal of the main air-currents at hundreds of American collieries, one of the most important of the purposes for

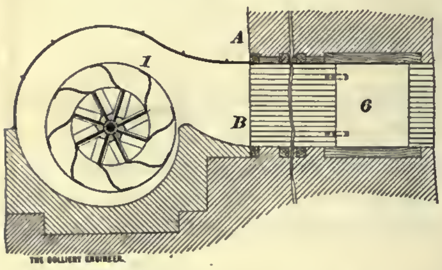


Fig. 1. Blowing Fan

which provision was made has sometimes been lost sight of, with most serious consequences, as at the Harwick colliery, near Pittsburg, where 181 men were killed by an explosion of firedamp in January, 1905; the fan, which was primarily an exhaust one, but reversible, was run as a blower, without change, during several weeks of severely cold weather, until at the time of the explosion the accumulated ice at the downcast shaft bottom had reduced the area to 9 square feet.

On reversing the air, as part of the operation of extinguishing an underground fire, it must be said that before recourse is taken to reversal, the person directing the operation must have an intimate personal knowledge of the geography of the mine, of the distribution of the air, and a clear idea of the effects of a change of direction of ventilation on the issue and direction of flow of firedamp from the coal and gob.

A large underground fire broke out at one of the best equipped mines in Pennsylvania in the year 1909, and I was requested to help. When the colliery was reached (1 hour after the summons), the smoke issuing from the upcast (hoisting) shaft was very dense, so dense that the order was given to extinguish all lights burning round the fringe of the smoke. By holding his breath and deliberately walking into the smoke, up to the edge of the shaft, the writer was able to observe a sensible brightening of the flame on his safety lamp. The fan was of the blowing reversible type, but the side drifts had not been completed at the time when it was installed, so that the preparations for changing it to an exhaust fan (which had been going on for some time) occupied a period long enough to allow of the situation being taken in. It was found that the returns contained carbon monoxide in such quantities as to make it imprudent to pass the air back upon the fire, that all roads in which work was necessary to divert it were foul, and that there was some danger of driving the firedamp through openings made by the fire directly upon it. The fan was not therefore reversed.

The writer's first experience of reversing the main air-current in a mine, in which an underground fire had existed, was in February, 1893. The fan was a blowing one, and as there was no means of getting down the small air-shaft, the fan was made reversible, after the manner practiced at that time in a few collieries in the anthracite regions of Pennsylvania. The fire was supposed to be drowned out. The shafts had been sealed for two months and water had been poured through a 5-inch pipe from the surface to a point near the seat of the fire. The length of this pipe was 1¼ miles. It was decided to make an attempt to enter the mine, although upon examining the samples of air obtained from time to time, through a valve in the scaffold of the upcast shaft, it was found that the proportion of carbon dioxide continued to increase right up to the time fixed for reentering the mine; and the proportion of firedamp present was too great to ignite in the presence of the existing carbon dioxide. To open the pit, only the seal in the upcast was removed. One cage was taken off, and a small fan, producing a maximum volume of 4,000 cubic feet of air per minute, was connected to the cageless compartment. Standing on top of the available cage, the writer with two other men divided the shaft into upcast and downcast by tight brattice cloth as they passed down. Slow progress was made in extending this brattice into the workings for the first 500 feet from the shaft bottom; but having reached the point where the road was solid, shields of brattice cloth were constructed Each shield had a door in its center 2 feet square; the edges of the doors were stiffened by strips of wood, and each shield was provided with wood stretchers in order to force the fabric against the walls. One of these movable shields was always standing in advance of the brattice, which was carried on to within a few feet of the

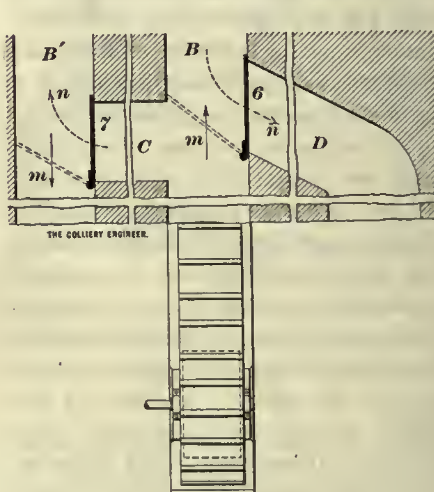


Fig. 2. Reversing Arrangement

shield; then a man with a rope round his body passed through the square door, carrying a fresh shield, with its stretchers folded up. This shield was set, say, 40 feet in advance of the brattice, the one imme-

*Read before Manchester Geological and Mining Society, Manchester, England, Feb. 10, 1914.

diately in front of the brattice was removed, and the work of bratticing the space uncovered by this process was begun. When the air was found to be too foul for a man to work, four men pushed the shield forward, instead of setting up another, holding the edges close to the walls as they went forward. All this trouble was taken to prevent feeding the fire, then known to exist, and to prevent the atmosphere containing firedamp from becoming explosive. This system worked successfully until a stone drift was reached. Cracks in the side wall here became too numerous and large to be successfully stopped, and it was therefore found impossible to further control the air. Men familiar with the mine said that this drawing through side breaks was due to a door having been blown open on the night of the explosion which caused the fire. The writer and a deputy made a quick walk to close this door, and on the way found the body of a man who was lost on the night of the explosion, he having evidently been trapped by afterdamp in making his way out for help. When near the door which they hoped to close, a sharp explosion took place; but owing to water having stood within 15 inches of the roof, between them and the seat of the fire no flame reached them. The main force of the explosion had spent itself in depressing the elastic surface of the water gathered in the gobs and open roads adjacent to the seat of fire, thus raising the water in the neck, through which alone the blast could reach the party. Afterdamp overtook them, but only at a point a few yards distant from fresh air. In the same mine 5 years later, when a similar fire occurred, 23 men were killed by an explosion of firedamp which followed. They had been allowed to wander aimlessly about the pit beyond reach of succor.

Figs. 1 and 2 show a method of reversing a main air-current independently of the fan. This method, while designed for drift pits only, could be adapted for shafts. The fan is shown in Fig. 1, and in this case is a blowing fan only. There are three openings shown in Fig. 2, *B′* is the main hauling road and ordinarily *B* the main intake, *D* a short road leading from *B* to the outcrop, and *C* a connecting road between the intake and return. Door *7* is hung at the haulage road end of *C*, separating the intake and the return. A door *6* is hung in *B* at the mouth of *D*. The operation of reversing is to swing the door *6* across *B* to the position shown by the dotted lines, and to swing the door *7* across *B′*. The air which, until these operations were carried out, traveled in the direction of the clear arrows, now travels in the opposite direction, as shown by the dotted arrows. The scheme further provides for double doors, one placed behind *6* in *D*, and one placed behind *7* in *C*. This form of reversal proves very satisfactory; it is cheap and simple, and was the outcome of the writer's anxiety with respect to large and valuable collieries where blowing fans only were used 15 years ago, and continue to be used to the present day. In the event of a large fire occurring inby, there was no possible chance of conveying material to build it off, except by men carrying it several miles, there being no road laid in the main intake. The scheme provides for the use of wire ropes to operate the doors from outside.

Ventilating Efficiency

About eight years ago the New River Co., at its mines in Fayette and Raleigh counties, W. Va., installed six 18-foot fans of 110,000 cubic feet capacity each. They were run by steam and their efficiency was 33 per cent., which, although not high, was considered very good. Recent years have brought about rapid development in fan manufacture and the above company is now replacing each one of the large fans with a smaller but more efficient one.

Fig. 1 shows the Scarbro mine fan house. In the foreground is seen a recently installed 9-foot Jeffrey fan which is belt driven by a 75-horsepower induction motor. This small fan has a capacity of 240,000 cubic feet and is 75 per cent. efficient. The old fan being torn down is seen to the rear.

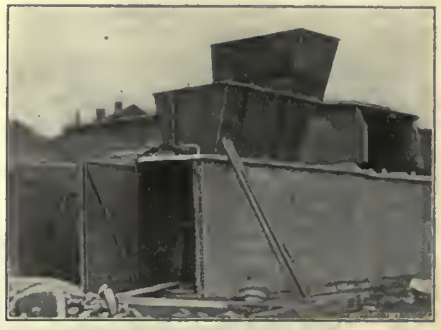


Fig. 1. New vs. Old

The company has installed a gasoline engine by the side of the motor. In case of a line breakdown or the shutting off of the power for any reason, the belt to the fan is slipped from the motor onto the pulley of the gasoline engine. The latter is already primed and the momentum of the fan would start it. This effectually prevents any halt in the ventilation.

Institute Meetings

The following meetings have been announced thus far:

Kentucky Mining Institute and Statewide First-Aid Field Meet, at Pineville, Ky., on May, 14 and 15, 1915.

West Virginia Statewide First-Aid and Mine Rescue Field Meet at Huntingdon, W. Va., May 14, 1915.

Alabama Safety Association, at Birmingham, Ala., on May 28 and 29, 1915.

Rocky Mountain Coal Mining Institute, at Trinidad, on June 8, 9, 10, 1915.

West Virginia Mining Institute, at Wheeling, W. Va., on June 15 and 16, 1915.

The following organizations will hold meetings at the Panama-Pacific International Exposition ground:

September 17–18. The American Institute of Mining Engineers.

September 20–25. International Engineering Congress.

September 20–22. American Mining Congress.

September 22. California State Mine Rescue and First-Aid Contest.

September 23–24. Third annual joint field meet of the Bureau of Mines and the American Mine Safety Association.

September 27–30. National Safety Conference, under joint auspices of the National Safety Council and the California Industrial Accidents Commission. September 28 will be devoted to the mine safety conference.

Dynamite Does Not Shoot Down

Written for the Colliery Engineer

There is a wide-spread belief that dynamite shoots downward, while black powder shoots upward, or at least not downward more than in any other direction. This belief, which is really an error, grows out of the fact that it is possible to break a stone by exploding dynamite which is merely laid on the upper surface, while the use of black powder under similar conditions will produce no more effect upon the stone than that due to the heat of the burning powder. Naturally, one who sees this phenomenon may assume that the black powder has exerted all its force upward, while the dynamite has acted downward.

Really, it is just as impossible for the black powder to act more in an upward direction than downward, or for the dynamite to act more in a downward direction than upward, as it is for a man to raise a weight without pushing downward on the ground. It is absolutely impossible for any force to be exerted in one direction without having an equal force or reaction in the opposite direction, just as impossible as it would be to split a piece of wood with a wedge if only one side of the wedge were in contact with the wood.

What really happens is something like this: when the black powder, piled in a heap on the surface of the stone, is ignited, it burns. This combustion is rapid it is true, but is not a real explosion; in fact black powder cannot be exploded unless it is confined. The decomposition of black powder is a rapid combustion in which oxygen, freed from the nitrate of the powder, unites with the charcoal and sulphur, with the production of a large volume of gas at a high temperature. If the powder is burned in the open air, this combustion proceeds comparatively slowly, the fire spreading from one particle of powder to another, just as fire in a stove spreads from one piece of coal to another, each particle being ignited when the heat from other particles has raised it to the igniting point. While this combustion is rapid, still the gases are produced so slowly that they have no difficulty in displacing the air which surrounds the heap of powder, and therefore when there is no stable base against which the gases can push upward there can be no strong pressure downward.

When black powder is confined in a bore hole or the barrel of a gun, the gases which are given off by the burning of the particles first ignited compress the confined air, and this compression produces sufficient heat to ignite all the particles, and also some of the hot gases from the burning grains of powder come in contact with other grains. Thus the air surrounding the powder grains is raised to the ignition temperature and the powder ignites almost instantaneously and the grains burn simultaneously and very rapidly. Under such circumstances the gases are given off so rapidly that they have no time to escape through such small passages as may be open. It is impossible for this action to take place when the powder is merely spread upon the top of the rock, since there is nothing to cause the ignition of all the grains at once because there is nothing to confine the gases.

On the other hand, the explosion of dynamite is not a combustion like that of black powder, but the sudden decomposition of a very complex molecule, with the production of a large amount of gas from a comparatively small volume of powder. This decomposition is started by a shock and every particle of the powder which is subject to a shock of the right kind is decomposed at the instant when it is shocked. This decomposition is started by a detonator and spreads with extreme rapidity. In the case of blasting gelatine the velocity is about 7,700 meters per second.

When such an explosive detonates on the surface of the rock two efects are produced: The first, is that caused by the force with which the molecules set free by the decomposition of the powder are hurled outward. While the molecules are very light, their velocity is so great that they do produce a real effect and pulverize the rock surface exposed to their action.

The second, is that due to the pressure of the expanding gas. In the case of this rapid explosion, the gases are given off with such extreme rapidity that there is no time for the surrounding air to be moved out of the way as fast as the gases are produced. Therefore a strong pressure is exerted against the rock. This pressure is due to the inertia of the air, which is pushed out of the way by the powder gases. Inertia varies as the square of the velocity, and it is the high velocity with which the gases are evolved from rapid explosives that enables them to produce effects not produced by black powder.

One hundred grams (.22 pound) of black powder when confined in a gun or bore hole, so that it really explodes, will give off 28.6 liters (10 cubic feet) of gas in 455 millionths of a second. The time required is very much longer when the powder is merely piled in a heap. The same weight of blasting gelatine gives off 82.8 liters (29.2 cubic feet) in 11 millionths of a second. It is principally this difference in the time required for the evolution of the gases which determines the difference in the effect of the two

explosives. Not all of the rapid explosives are as rapid and as violent as blasting gelatine, but all of them are much more rapid than black powder.

The force of the dynamite, like that of the black powder, is really exerted equally in all directions but dynamite ruptures the stone because of its rapidity of action, while the black powder is able to move the air out of the way and exerts no great pressure upon the stone. The effects of these two explosives are sometimes compared to pushing a nail with a hammer in the case of black powder; and to driving it with a blow in the case of the dynamite.

Mineral Exhibit at San Francisco

To illustrate the development of the mineral resources of the United States the Geological Survey exhibit at the Panama-Pacific International Exposition includes a graphic representation of the output of the various mineral products of the country based on the production per capita during the centennial year, 1876, and at the present time. Bituminous coal is represented by a block of coal weighing 1,600 pounds, the per capita production in 1876, and by another block weighing 5 tons (10,000 pounds), the per capita output in 1913. The anthracite blocks, on the other hand, indicate relatively small gain, from 1,140 to 1,880 pounds.

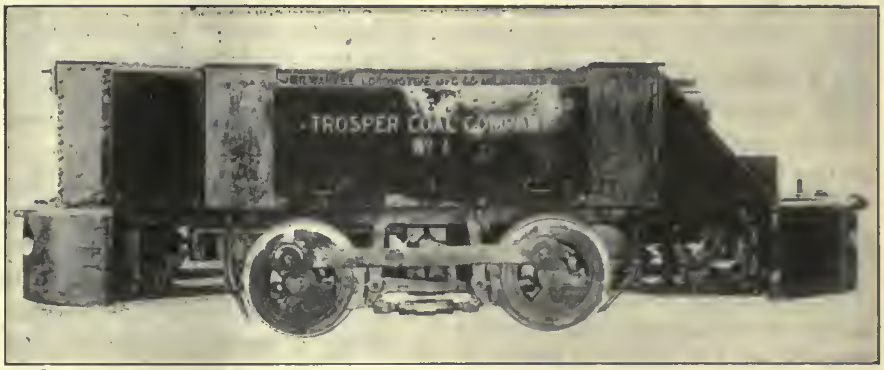
The per capita production of coke has increased from 134 pounds in 1876 to 700 pounds in 1913. At the earlier period no other than beehive coke was manufactured in the United States, but since then the interesting feature of coke manufacture has been the development of the retort oven, by which valuable constituents of the coal other than coke are recovered. The exhibit at San Francisco shows the quantity of coal consumed in retort ovens in this country in 1913, the quantity of coke produced from it, and the quantity of coal tar, benzol, gas, and sulphate of ammonia recovered.

Gasoline Locomotive Haulage

Its Cost as Compared to Mule Haulage at Mines of Trosper Coal Co., Bradel, Ky.

Written for The Colliery Engineer

THE great progress that has been made in the development and perfection of gasoline locomotives for coal haulage in the past few years, and the results obtained by their use, clearly demonstrate their adaptability to this class of service.



Gasoline Locomotive, Trosper Coal Co.

Gasoline locomotives have already been installed in many mines where mule haulage was formerly employed. They are becoming an important factor in this field, not only because of their high efficiency and great economy, but also because of their low cost of installation and maintenance, as they require no auxiliary power plant, overhead wires, nor bonding of rails.

One of the important features of gasoline locomotives is their low cost of maintenance, due to the fact that they consume no fuel when not in operation, so that when the mine is shut down for one reason or another, the maintenance cost of the locomotive ceases, or when a load is not ready for transportation to the tipple the locomotive engine is stopped. When employing mules for haulage, the maintenance cost continues, as they require feed and attention at all times, whether working or idle.

At one of the mines of the Trosper Coal Co. at Bradel, Ky., where mules were formerly employed, an "L-25" 5-ton Milwaukee gasoline locomotive is hauling the output with greater dispatch and at a saving in haulage costs of over 42 per cent.

This mine has been operated by the present company for the past 5 years. Compressed air and punchers are employed in mining the coal, their present output, owing to depressed business conditions, being approximately 400 tons per day, averaging 52 per cent. block, 20 per cent. round, and 28 per cent. slack.

The following comparative haulage costs showing haulage expense for both gasoline and mule haulage at this mine, were furnished by the Trosper Coal Co. and show that this type of locomotive is ideally adapted for coal haulage.

Cost of Haulage with Mules Formerly Employed

	Per Day
Feed and care of 9 mules at 60c. each	$5.40
Drivers, 3 at $2.25 each	6.75
Interest on investment, 9 mules at $180 each at 6 per cent. per annum	.33
Depreciation, 9 mules at 26⅔c. each	2.40
Total haulage cost with mules	$14.88

Cost of Haulage with Gasoline Locomotive

	Per Day
Operator, 1 at $2.50	$2.50
Coupler, 1 at $2	2.00
Gasoline consumed	1.75
Oil consumed	.15
Interest on locomotive investment at 6 per cent. per annum	.60
Depreciation on locomotive at 10 per cent. per annum	1.00
Repairs for locomotive	.50
Total haulage cost with gasoline locomotive	$8.50
Total mule haulage cost per day $14.88, per year of 300 working days	$4,464
Total locomotive haulage cost per day $8.50, per year of 300 working days	2,550
Saving in haulage cost per day $6.38, per year of 300 working days	$1,914

The average one-way haul from the mine to the tipple is 2,700 feet with a 700-foot grade of 1½ to 2 per cent. against the loads.

The average train per trip consists of 15 loaded cars, gross weight approximately 4,700 pounds per car, or a total gross weight of 70,500 pounds per train of 15 cars, the empty cars weighing 1,700 pounds each and carrying a load of 3,000 pounds each.

The locomotive used is one of the most recent of the gasoline machines.

It is equipped with a 5″ × 6″, four-cycle, four-cylinder engine of the vertical type, especially designed for this class of service and capable of delivering 25 horsepower to the wheels at 800 revolutions per minute. The engine is located over the front axle away from the operator and drives a two-speed transmission direct through a universal coupling. The transmission drives the rear axle through spur gears and is equipped with two friction clutches, one for forward and one for backward travel.

On narrow-gauge locomotives of this make and type, the wheels are located inside the frame, the axles being connected by sprockets and a heavy driving chain, where on the outside wheel locomotives, for track gauges of 35 inches or over, the wheels are connected by forged connecting-rods.

An electric generator provides current for both the ignition and lighting systems, and a storage battery furnishes the current for the lighting system when the engine speed is low, and also furnishes the current for starting the engine.

The cooling system consists of a radiator and a centrifugal water pump, by means of which the water is kept in circulation and effectively cooled.

This locomotive is geared for two speeds of 3½ and 7 miles per hour, and on a straight clean dry rail and with cars that do not exceed a drawbar pull of 30 pounds per ton on a level it has a rated hauling capacity in tons of 2,000 pounds (exclusive of its own weight) as follows:

Low Gear—3½ Miles Per Hour

Level	1 per cent.	2 per cent.	3 per cent.	4 per cent.	5 per cent.	6 per cent.
66.6	38	25.7	18.8	14.5	11.5	9.3

High Gear—7 Miles Per Hour

Leve	1 per cent.	2 per cent.	3 per cent.	4 per cent.	5 per cent.	6 per cent.
44.7	24.8	16.3	11.5	8.5	6.5	4.9

One Year's Experience with the Electric Safety Lamp

*By C. Johnson**

In order to make a comparison, with regard to the cost of coal getting at the working face, where electric lamps are used, as compared with oil lamps we have always used, I took two districts working in the same seam and under similar conditions; the advantage certainly goes to the electrically lighted district, the wage earning power of the workmen being thereby increased.

So far as benefit to health is concerned, I am of opinion that introducing a lamp with a greater illuminating power has tended to reduce the number of nystagmus cases. During the year 1913, at our small pit we had a number of persons affected with this disease; for the year 1914 we have had none. What we did was to keep several spare lamps, so that when we saw a workman whom we suspected to be suffering from or developing nystagmus, we gave to him an electric lamp; and today we have repeated testimony from these men that they can now do their work with greater comfort, and also read the newspaper at home without eyes or head aching when so doing.

It has often been said that, given a better light, the number of accidents would be reduced. That may be so, but it is not my experience. We have had as many accidents in the year 1914 as during the year 1913, but they have been largely of a minor character; so that whilst the number of accidents has been the same, the compensation cost has been reduced by half. Another point worth noticing is that of the accidents which have happened, 72.73 per cent. occurred to persons using oil lamps.

The chief advantage of the electric lamp is that it yields a better light, and as a consequence should conduce to greater safety and more comfort on the part of the worker. The chief disadvantage is the impossibility of making tests for gas, and should those responsible for doing this become perfunctory in the discharge of their duties, serious consequences may ensue. An instructive incident occurred in my experience illustrating this aspect of the question. During the month of December, 1914, when going through a district, I found in one working place that, because the persons who usually had the oil lamps had not come to work that day, the others had gone into the drift without inquiring for an oil lamp, or apprising any official of the absence of oil lamps there. This incident made it necessary to take electric lamps from all chargemen and issue notices that no persons are to work in any place without the chargeman having in his possession during the whole of the shift a flame safety lamp for gas testing.

*Abstract from lecture before the Branch of the Association, at the Mining School, Stoke-on-Trent, England.

International Engineering Congress, 1915

Volume 3 of the Transactions of the Congress will comprise a series of papers on the general subject of Municipal Engineering. The broad field will be treated under nine topics covering the general subjects of city planning, streets, drainage, disposal of waste, water supply, protection against fire, transportation, public utilities, and rural highways. The secretary is W. A. Cattell, 417 Foxcroft Building, San Francisco, Calif.

The paper on "Advantages of the Western Kentucky Field," by F. V. Ruckman, published on page 488 of our April number, was read before the Kentucky Mining Institute and credit should have been given to that organization.

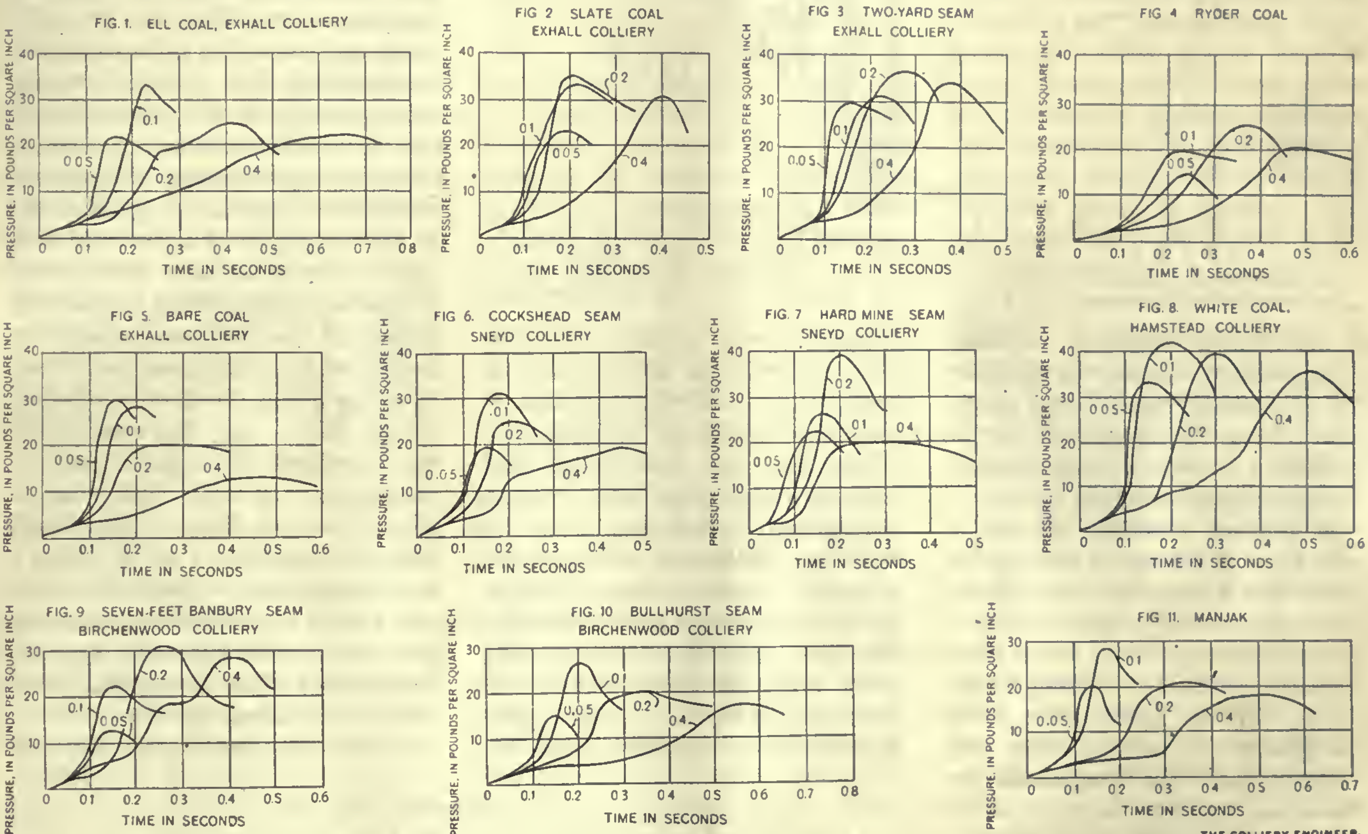
Coal-Dust Explosion Experiments

Showing Effects of Density of Dust Cloud and Roughness of Surface of Mine on Pressure of Explosion

*By J. D. Morgan**

STATEMENTS concerning the non-inflammability of certain coal dusts must be accepted with reserve. It does not appear to be possible to establish any standard of inflammability that is independent of the source of ignition, for in all cases the inflammation of a dust cloud is to some extent dependent on the quantity of heat in the igniting medium. This is true also of gas mixtures, for some mixtures, which can be exploded by what are called fat sparks, cannot be exploded by small sparks produced under certain conditions.† The explosibility of any dust cannot be established definitely from its chemical composition, and this applies especially to coal dusts.

The question arises whether the relative inflammability of different coal dusts under the conditions which obtain in a mine can be determined by small scale experiments. In the writer's opinion the answer is in the negative. Only operations on a large scale can yield reliable information of practical value to mining engineers. From small scale laboratory experiments a certain well-defined result is obtained with all readily inflammable coal dusts; namely, that the rate of inflammation depends upon the density of the cloud. The validity of this result appears to be independent of the magnitude of the experiment. Starting with a cloud of given density, the speed with which a flame develops and spreads diminishes as the density is increased. This is shown by Figs. 1 to 11. In each figure the four curves were obtained by explosion in a small closed chamber, having a capacity of 100 cubic centimeters, of different quantities of dust; viz., .05, .1, .2, and .4 gram.



DIAGRAMS SHOWING EXPLOSIBILITY OF DIFFERENT KINDS OF DUSTS

*Read before the North Staffordshire Institute of Mining and Mechanical Engineers, March, 1915.

†"The Ignition of Coal Gas and Methane by Momentary Electric Arcs," Prof. W. M. Thornton, Dr. Sc., Transactions Institute Mining Engineers, Vol. 44, page 145.

‡"Dust Explosions," by J. D. Morgan, Proceedings of the Institution of Civil Engineers, Vol. 196, page 334.

The apparatus used is illustrated in Fig. 13. It consists of a cylindrical explosion chamber having a deep detachable cup at the bottom, in which is fitted the valve *C*. An air injection pump is connected to the lower end of the cup. The expansion of the cup to the diameter of the cylinder is gradual. Ignition is obtained by heating the platinum coil *E* which is wound on a quartz tube. Near the upper end of the cylinder a branch opening connects to the pressure recording device.

A weighed quantity of dust is placed in the bottom of the cup and raised into a cloud by a puff of air. When this cloud reaches the coil, ignition occurs and the flame spreads downward through the cloud. It is found that, with charges up to a certain limit, very uniform clouds can be obtained; but that when this limit is exceeded, the cloud reaches the coil before the whole of the dust is raised and the pressure of explosion closes the air valve. In the experiments recorded, there was evidence that .2 gram, or rather less, was the maximum charge that could be completely raised. The explosion curve obtained with a .4-gram charge does not show the result that would be obtained if the whole of the charge entered the cloud. With the quantity which is raised, a marked diminution of explosibility is found as compared with the smaller charges, and this diminution would be greater if the whole of the large charge could be utilized.

FIG 12. CURVES OF EXPLOSIONS IN HOME OFFICE GALLERY SHOWING THE EFFECT OF EXPLOSIONS OF A FEW SMALL CONSTRICTIONS IN GALLERY

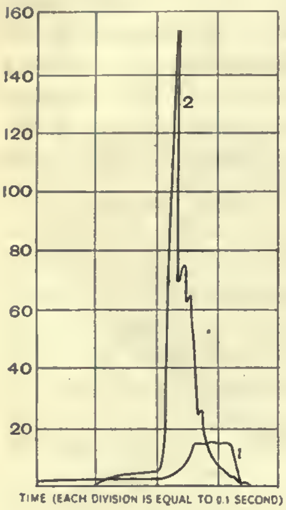


FIG 13 MORGAN'S EXPLOSION APPARATUS

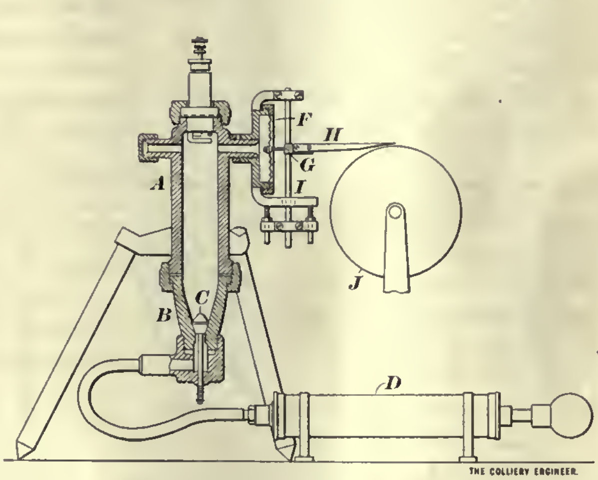


Table 1 shows the proximate analyses of coals used in tests illustrated in Figs. 1 to 11.

Density and Pressure.—Only the essential curve is shown in each case. It will be noticed that in almost all the tests the time taken to reach the maximum pressure increases with the quantity of dust, and that the average rate at which the pressure increases during the explosion diminishes with increase of dust. This is equivalent to stating that an increase in the destiny of the dust cloud has a diminishing effect upon the inflammability of the cloud. The fact is one of great importance in connection with the committee's recommendation as to the quantity of incombustible dust to be used in mines, for it immediately suggests the questions: Is the same result found in large scale experiments, and, if so, on what amount of dust in the mine is the quantity of incombustible dust to be computed? Assuming the result to be the same under mining conditions, it follows that the mine may be in a more dangerous condition after it has been cleaned up than when a large excess of coal dust is present, provided that after cleaning there is sufficient dust left to form an explosive mixture when disturbed. From small scale experiments it appears that excess of coal dust has the same effect, but not to the same extent as incombustible dust, in that it retards inflammation. In this connection it may be useful to cite an experiment previously described by the author in another paper.‡ A glass tube, 10 feet long, closed at one end and open at the other, was strewn with lycopodium dust. When a small explosion of the dust was started at the closed end, the consequent rush of air swept up the dust in advance of the flame, and the combustion was continued with great velocity throughout the tube. But when a motor horn was fitted to the closed end and sounded, so as to bring a large part of all the dust in the tube into a state of suspension, the flame from the initial explosion was always stifled after it had proceeded about a foot along the tube.

Another important result obtained

TABLE I

	Exhall					Sneyd		Hamstead	Birchenwood		Trinidad
	Ell Coal (Fig. 1) Per Cent.	Slate Coal (Fig. 2) Per Cent.	Two-Yard Seam (Fig. 3) Per Cent.	Ryder Coal (Fig. 4) Per Cent.	Bare Coal (Fig. 5) Per Cent	Cockshead Seam (Fig. 6) Per Cent.	Hardmine Seam (Fig. 7) Per Cent.	White Coal (Fig. 8) Per Cent.	Seven-Peet Banbury Seam (Fig. 9) Per Cent.	Bullhurst Seam (Fig. 10) Per Cent.	Manjak (Fig. 11) Per Cent.
Water........	9.00	9.97	10.15	10.00	7.58	1.54	2.01	10.95	2.18	1.20	2.30
Volatile matter.........	33.00	31.24	28.08	31.15	31.80	32.81	33.51	35.17	35.63	31.70	60.05
Fixed carbon.	51.42	56.75	57.87	57.37	55.06	63.45	61.24	48.83	59.88	64.10	36.90
Ash..........	6.58	2.04	3.90	1.48	5.56	2.20	3.24	5.05	2.31	3.00	.75
Totals.....	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

NOTE.—All samples were dried for 1 hour at 107° C. The volatile matter was estimated by the standard American method.

from tests such as those recorded in Figs. 1 to 11, is that when the quantity of dust in suspension is increased beyond a certain critical amount, the explosion pressure is diminished. This result is true for gas explosions as well as dust explosions. It is well known that if, in a mixture of combustible gas and air, the proportion of gas is below a certain limit, general inflammation of the mixture cannot be obtained. Experience indicates that the same is true for combustible dust and air mixtures. Below and above certain limits a flame is incapable of traveling throughout the mixtures, but between those limits the flame appears to be capable of propagation throughout the mixture. Commencing at the lower limit, and proceeding toward the higher limit, a dust mixture behaves exactly like a gas mixture, in that at first the pressure of explosion increases concurrently with increase in the proportion of dust. But, when a certain critical proportion is exceeded, further increase of dust is attended by a diminution of the pressure of explosion, and this continues until the higher limit is reached.

Summarizing the foregoing results, one finds that when the amount of coal dust is below the "lower limit," or above the "higher limit," indefinite propagation of a flame cannot occur. When the amount lies between those two limits, but is in excess of a certain critical quantity, the coal dust itself diminishes both the rate of inflammation and the pressure attained. It must be understood that the foregoing criticisms are based only on laboratory experiments, but it is desirable that experiments should be carried out on a large scale in order to determine the effects of excess on the explosibility of coal dusts, and thus provide practical information which can be obtained in no other way.

From the foregoing deductions it may be argued that an excessive amount of coal dust in a mine is a natural protection against dust explosions; but it must not be overlooked that, notwithstanding the retarding effect of excessive coal dust on inflammability, a real danger is introduced by excess. If we suppose that sufficient dust is disturbed to produce an extensive cloud, the density of which is considerably greater than that which will permit of the most rapid inflammation, and that the cloud is ignited, then while the flame is spreading the cloud in advance of the flame is rapidly settling and becoming less dense. If the flame can persist until it reaches a zone of critical density, it may on reaching that zone produce a violent explosion, and the above process may then be repeated.

If the addition of incombustible dust is useful, its effect should be most markedly shown in explosions of critical mixtures which give the maximum explosion effects. Presumably the quantities of coal dust employed by the committee in some of the reported tests were such as would give these mixtures. In the Fifth Report it is stated that the committee entertains no doubt that an easily raised incombustible dust, if properly placed, is capable of dealing effectively with a feeble inflammation, even under the most adverse conditions; also that mixtures in equal proportions of coal and incombustible dust are difficult to ignite, but when ignited may propagate flame throughout a large gallery. Judging from the details given in the Fifth Report, it would appear that the committee's work chiefly establishes the usefulness of stone dust in preventing the initiation of an explosion. With regard to the effects upon an explosion that has developed beyond the ignition stage, the results are inconclusive, and it seems necessary that further work should be done in this direction, attention being directed to the effect of varying the quantity of coal dust as well as the proportion of added stone dust.

Effect of Surface of Mine Workings on Dust Explosions.—It is well known that a gas or dust explosion is accelerated by increase of the internal motion of the gas or dust mixture. The writer has noticed that when a gas explosion is produced in a small steel tube which is open at one end and closed at the other, the explosion being initiated at the closed end of the tube, the effect is more violent when the interior of the tube is covered with a rusty incrustation than when the interior is smooth. Apparently, the eddying motion set up by the rough surface over which the gas moves accelerates the explosion.

The testing gallery at Eskmeals consists of a comparatively smooth tube. In the Fourth Report, the committee describes the effect of constrictions in the gallery on dust explosions produced therein. These constrictions were in the form of rings 6 inches deep. In one series of experiments, three constrictions were introduced 50 feet apart at points 300, 350, and 400 feet distant from the point of ignition. The very remarkable difference caused by the constrictions is illustrated in Fig. 13. The two curves were produced by a manometer placed 50 feet from the open end of the gallery. The lower curve shows the record of an explosion when the rings were not used. A maximum pressure of 16 pounds per square inch was produced. The higher curve shows a pressure of 152 pounds per square inch produced when rings were used.

It seems highly probable that adulterated coal dust mixtures which were feebly explosive in the clear gallery would be energetically explosive in the same gallery provided with constrictions. Having regard also of the fact that a mine working has a rough interior and is more or less obstructed at intervals, experiments in a smooth gallery are of little or no value as criteria of conditions in a mine.

William Penn, in his Charter of Rights, provided that for every 5 acres of forest cleared 1 acre should be left in woods. Foresters today maintain that one-fifth of every farm should be in timber.

Coal Fields of South America

The Resources of the Different Countries and the Amount of Their Importation of Coal

By Wilbur Greeley Burroughs

DUE to the European war and the completion of the Panama Canal the attention of the business world of the United States has been drawn to South America. Therefore, in the present article will be considered, briefly, the coal resources of the various countries of that continent, and their importation of coal from foreign lands.

Geologically the coals of South America, as given in "Coal Resources of the World," are Paleozoic and Tertiary (Fig. 1). The Permo-Carboniferous lie east of the Andes, outcropping in southern and eastern Brazil and underlying part of Uruguay and possibly a large part of Argentina; while the most westerly outcrops of this age are probably those in Bolivia and in isolated localities east of the Andes in Argentina. The Tertiary coals occur in the coastal zone of southern Argentina and Chile, and in the mountainous regions of Peru, Ecuador, Colombia, and northern Venezuela. In western Argentina and Venezuela are coal seams which are thought to be of bituminous origin.

The importance of those countries' coal fields which have been investigated and estimated is shown in Table 1, given in "Coal Resources of the World."

ARGENTINA

Coal bearing formations occur at various points in Argentina, but particularly in the provinces of Mendoza, San Juan, and the Territory of Neuquen. There is no doubt as to the industrial value of the seams of these regions, states E. Herrero Ducloux in "Anales de la Sociedad Cientifica Argentina, Vol. LXIII." Coal mining operations, however, are as yet in an early stage, one of the main reasons why this is so being on account of lack of transportation facilities. Only on the Salagasta coal seam, in the province of Mendoza, northwest of Mendoza City, has much exploration work been done.

This Salagasta coal bed, states E. Hermitte, outcrops in a number of places and has been opened by a

FIG. 1. SHOWING COAL FIELDS OF SOUTH AMERICA

tunnel to a depth of 105 meters below the surface; also, a boring made in 1910 cut a seam of coal at a depth of 606 meters. It is believed that the bed has a thickness of from 3.50 meters to 5 meters. If this is correct, adds the above mentioned authority, then we have here in sight 300,000 tons of coal, and the workable reserve would approximately

TABLE 1. ESTIMATE OF THE COAL RESERVES OF SOUTH AMERICA IN MILLIONS OF TONS

	Class A Anthracite Coals Including Some Dry Coals	Classes B and C Bituminous Coals	Class D Subbituminous Coals, Brown Coals, Lignite
Argentina		5	5
Chile		3,048	3,048
Peru	700	1,339	2,039
Venezuela		5	5
Colombia		27,000	27,000
Total	700	31,397	32,097

amount to 5,000,000 tons. But the basis on which this is figured is somewhat uncertain.

Analyses of the Salagasta coal, which is classed as bituminous, are here given:

	A	*B*
Volatile matter	33.02	20.79
Fixed carbon	48.23	63.88
Ash	14.15	11.13
Moisture at 105° C.	4.60	4.20
Total	100.00	100.00
Calories	7,221	5,630

Although Argentina possesses coal fields, they have not as yet been developed sufficiently to meet in any degree the demand for coal in that country. Consequently, coal is imported into Argentina in large quantities. The following statistics furnished the writer for use in this article, by Franklin Adams, editor of the *Bulletin* of the Pan American Union, show the importance of this import trade:

IMPORTATIONS TO ARGENTINA IN 1912

	Metric Tons*	Value
United Kingdom	3,499,989	$24,499,923
United States	115,901	811,307
Germany	56,450	395,150
Austria-Hungary	16,990	118,930
Belgium	4,759	33,313
Netherlands	386	2,702

Total importations from all countries: 3,707,956—$25,955,692.
* 2,204.6 pounds each.

In 1913 the total imports were 4,046,278 tons and in the first 6 months of 1914, 2,097,087 tons.

The consumers of steam coal, states L. J. Keena, Consul General for the United States at Buenos Aires, in Consular and Trade Reports, are the railroads, electric light plants, steamship lines, and industrial concerns generally. He continues, "the coal principally used is Cardiff coal, which has high volatile properties. In quantities of less than 500 tons Cardiff coal is sold at $9.50 United States currency, per ton delivered, and in larger quantities at a decreasing price, $8 per ton being the minimum normal price of steam coal in this market. This will be easily appreciated as a just minimum when it is considered that charter freight on coal to Argentina is nominally from $3.50 to $4 United States currency per ton. The British hold on the local market is se-

cured by the heavy British investments in railroads and public service corporations, by the well-known quality of the coal, and by the great movement in this port of British-owned shipping, which, while giving rapid and regular service on coal deliveries, also necessitates large coaling stations for general cargo and passenger steamers. It is also strengthened by the large British coal companies, which have ample deposits here for all general needs.

"In order that any settled business of good proportions be done in Buenos Aires in American steam coal, it is highly important that a coal deposit be established, in order to gather in some of the relatively smaller consumers who, though using several shiploads of coal per year apiece, will not finance their coal purchases as far ahead as would be necessary in purchasing coal from the United States with the consequent risk of running short because of insufficient steamship service.

"The steam coal carrying service from England to Argentina is excellent, and the coal is both well known and well sold. In order to compete successfully in this market, American producers must take these facts into consideration and prepare to meet that competition."

In this connection the bulletin recently published by the United States Bureau of Mines, entitled "United States Coals Available for Export Trade," by V. H. Manning, will be of value.

About 300,000 tons of gas coal are imported per year into Argentina, nearly the entire amount coming from South Yorkshire, England. The Compania Primitiva de Gas, of Buenos Aires, takes about 200,000 of the 300,000 tons. This coal yields 12,300 to 12,500 cubic feet of gas per ton, states Keena. The selling price in United States currency is about $7.25 per ton delivered. The coal received from England is all guaranteed double screened.

The usual method of unloading coal from a vessel at Buenos Aires is by means of baskets. However, a few docks have mechanical apparatus and at these places the coal is first loaded into iron buckets which are then moved by cranes. The unloading expense in United States currency is from 25 to 30 cents per ton "and is borne by the shipper selling on a delivered price unless otherwise stated in the contract. In interior towns all coal handling is done with baskets carried by peons to destination."

In Buenos Aires charcoal or gas is used for cooking in the place of coal, while in the country coal and wood are used. Coal for heating purposes usually is procured at the beginning of winter in May, for being in the Southern Hemisphere it is winter when in the United States it is summer, and vice versa. In small quantities for domestic use coal costs, in United States currency, $12 per ton, coke $14.50 per ton, and charcoal $3.40 per 220 pounds.

(To be continued)

PERSONALS

Prof. Benjamin L. Miller, head of the Department of Geology of Lehigh University, and Dr. J. T. Singewald, of the Johns Hopkins University, have left for an extended trip through South and Central America.

The Delaware & Hudson Coal Co. announces the appointment of Charles H. Dorrance, Jr., formerly general manager of the Harwood Coal Co., and E. F. Pettebone, chief mining engineer for the D. & H. properties, as assistants to General Superintendent C. C. Rose, at Scranton, Pa.

Paul B. Lieberman, formerly assistant engineer of the Sprague Electric Co., has become Engineer of Tests for the Hyatt Roller Bearing Co. Mr. Lieberman will have charge of all tests, both laboratory and field, for the purpose of determining the exact saving to be effected by the adoption of Hyatt roller bearings to all applications.

Lee H. Parker, of the Stone & Webster Engineering Corporation, has been elected president of the Spray Engineering Co., at Boston, Mass.

Clarence Boyle, Jr., the Scranton, Pa., district manager of the Taylor-Wharton Iron and Steel Co., has resigned to go with Clarence Boyle, Inc., wholesale lumber merchants of Chicago, Ill.

William Roth, assistant superintendent of the Beaver Brook colliery of C. M. Dodson Co., at Beaver Brook, Pa., has resigned his position. Mr. Frank Packer has been appointed as his successor.

Harry McDonald has been appointed general manager, and Robert M. Pollock, general mine foreman, of the Washington Coal and Coke Co.'s operations near Star Junction, Pa.

The Spring Valley Coal Co., of Spring Valley, Ill., announces the appointment of L. H. Smith as general manager, succeeding the late S. M. Dalzell.

F. K. Day has been appointed division engineer of the West Virginia division of the Consolidation Coal Co., vice E. B. Moore, resigned.

Chief Charles H. Nesbitt, of the Alabama State Mining Department, has appointed Mr. Frank Albright as statistician of the department.

B. R. Lindsey, formerly connected with the mining department of the Cambria Steel Co., at Johnstown, Pa., has been appointed superintendent of the Bowood mine of the Republic Iron and Steel Co., at Smithfield, Pa.

The National Coal Co., of Seattle, Wash., announces the election of Stephen H. Green as president and general manager. Mr. Green was formerly general manager of the Wadsworth Red Ash Coal Co., at Birmingham, Ala.

George Watkin Evans, consulting mining engineer, has just returned from a professional visit to southeastern Alaska.

William Sharpe, mine foreman for the Consolidated Coal and Coke Co., at Dacono, Colo., has resigned to become superintendent of the Russel Coal and Coke Co., at Frederick. He is succeeded at Dacono by Stanley Bloss.

WITH THE EDITORS

Our Cover Page

OUR cover page shows one of the most important and pleasant of the ordinary events of a miner's life. It shows to some extent, at least, his hopes realized. It means the possibility of life for him and for his family; it means, too, compensation, the receipt of something for what he has given. We wish that the condition of the coal industry were such that these days would be accompanied by fatter envelopes for every miner.

There is one part of the picture which seemed to force itself in, for the picture was not taken to show it. It is in the picture only because it was in the fact; that is a man holding out his hand for contributions from the men who have just received their pay. This is not intended to be an essay upon the dangers of coal mining or a discussion of precautions for the prevention of accidents or an argument for compensation laws. It merely calls attention to a fact which exists in some form at every mine. Somewhere, though he may not stand upon the highway hat in hand, somewhere there is a man who has suffered in doing the work which other men are doing. He has lost his ability to maintain himself and his family, lost his productiveness. It would be a good thing if every man who goes into the mines could carry in his mind some such picture as this, giving him a constant realization of the dangers of his work, so that he would every day take the precautions which will minimize the risks.

The Coal Producer's Business

IT MUST be brought home to the producers of coal, again and again, and in many ways, that their business is something besides the production of coal. It is more even than the production of coal at low cost. It is the production of coal at low cost, plus the saving of every by-product that can be profitably saved, plus the careful preparation of coal for the market so that it will command the highest price, plus careful marketing to get that price, plus careful buying of equipment and supplies. The great and rapidly increasing demand for coal, until recent years, has made such minute attention unnecessary, but now that the capacity of developed mines has become greater than the demand, the days of easy money, when the amount of profit depended largely on the tonnage produced, are past.

Profit in the future must come very largely from economy of production and the stopping of leaks. It is possible that many men who manage the business have become so accustomed to things as they are that they cannot see desirable changes. Perhaps it will take something from outside to lift the coal industry out of the rut, but we hope that will not be necessary. The coal men themselves, the business men, the engineers, and the chemists, have the ability to solve the problems of the industry. But some of them are too apathetic.

Power production and distribution are better than they were, but they are not perfect. Too many plants are using the wrong stokers, or none at all, or poor boilers or poor water. Lubrication is just beginning to receive serious attention. The proper screening and cleaning of coal are not yet as common as they ought to be, though some foresighted men are selling clean coal where dirty coal finds no market. The utilization of wastes, except in the by-product coke oven and the production of power from unmarketable forms of coal, is unheard of; clay good for brick and pyrite; that is, good enough for the manufacture of sulphuric acid, are thrown away.

The time is coming and coming very soon, when all these economies will be practiced and a colliery will be a complete plant for the best utilization of the coal and everything connected with it.

The U. S. Bureau of Mines Press Agency

WE BELIEVE the United States Bureau of Mines does much good work, but we do not approve some of its methods. We should believe in it more if less were claimed for it. At this time we take occasion to express our opposition to the methods of the press bureau maintained by the Bureau of Mines. The recent disaster at Layland, W. Va., has been made the occasion of another exaggerated claim for great work performed by the Bureau.

While the claims made for the Bureau through the daily press contain nothing derogatory to the West Virginia state mine officials and the officials and employes of the various mining companies who gave or tendered their services in the rescue work, yet the impression is conveyed that the principal and greatest part of the work of rescue was taken by the Bureau of Mines.

This is not in accordance with facts.

Mining officials and officials of the Mining Department of the state of West Virginia were the leaders, and they, with the volunteer assistants from the employes of the New River and Pocahontas Consolidated Coal Co.

and those from the neighboring mines, were the men who deserve the credit. They pressed forward in the rescue work, exercising every precaution known to intelligent, practical mining men, and the helmet men followed. This does not mean that oxygen helmets are not of great value. Neither does it mean that the men wearing the helmets were devoid of personal bravery. But they were following the orders of the Bureau not to proceed "beyond the air" as determined by the effect of the atmosphere on a canary.

We know of course that a very small percentage of carbon monoxide in the atmosphere is fatal to a man. We also know that a man can stand comparatively many times as much carbon monoxide as a canary, and that with a properly adjusted oxygen helmet he need pay no attention to the percentage of carbon monoxide in the outer air as long as his supply of oxygen lasts.

If the officials of the Bureau of Mines want credit for rescue work, the first thing they should do is to recall their order to helmet men and place no restrictions on the brave men who don the helmets in time of necessity, except that of seeing that the apparatus is in proper order and properly adjusted. Let the men, who are taken from practical mining ranks, be the judges as to how far they should proceed in rescue work before turning back in order to prevent the useless sacrifice of their own lives. If this is done, the Bureau will not need a press agent. The technical and general press will give its officials full credit for all they accomplish and will extol every act of conspicuous bravery.

Discipline

DISCIPLINE is a necessity if there is to be a reasonable safety in coal mining. Necessary as it is in any industry, there is no other, except possibly that of transportation, where the safety of so many depends upon the acts of a single individual. Discipline on the railroad and the ship is a matter of course, and there is the most perfect confidence in its existence.

Comparatively, the problem in these cases is easy; but in a coal mine the conditions are entirely different. Here the danger is invisible and men grow tired of heeding the peril of unseen things, and careless. Then, instead of there being only one or two men whose action is likely to jeopardize the safety of hundreds, and who are strongly conscious of their responsibility as is true in most industries, in the mine it may easily be that the lives of all depend on the action of every single individual underground. Such widely shared responsibility is likely to be somewhat weakly felt.

Unfortunately many of the things which are dangerous and which may cause disaster are things which there is a real inducement to do. For instance, a miner's pay depends upon the number of tons of coal which he loads and, of course, it is easier to break down coal with dynamite than with black powder or permissible explosives, and it is a real temptation to smuggle dynamite into the mine in order that the work may be easier and the pay greater. Somebody does it one time too often and Layland is the result. It is easier to let the powder do all the work and shoot off the solid than it is to undercut coal and break it down properly. The result is blown-out shots. It is a real hardship to some men to go without smoking, and even though the mine be a little gassy, enough so to make safety lamps necessary, yet the chances are that the gas is not present in dangerous quantities and some men will yield to the temptation to get a light some way and have a smoke.

There ought to be knowledge on the part of every miner, of the conditions under which he is working and the possible consequences of his every act; and if we cannot have this knowledge fully and immediately, then we ought to have absolute discipline. There ought to be discipline by the mine officers so strict that any infringement of regulations intended for the promotion of safety would be met with such treatment that those regulations would be regarded with respect, even by men who did not understand them.

There ought to be discipline by the law. This ought to be such as to command the respect and loyalty of every man connected with the mine, from operator to humblest laborer. It ought to be so framed as to do all that a law can do to make mining safe and profitable, and at the same time there should be nothing in it to alienate the respect of those familiar with actual mining conditions.

Back of all this forced discipline, which works from above, there should be a discipline of each individual by himself. He ought to know what he is doing and what may happen if he does this or that. Knowing these things, he ought to be a man capable of assuming responsibility and willing to deny himself some trifling pleasure or to work a little harder—but even then, only as hard as he is expected to work—because of his knowledge that through his carelessness, not only may his own life be lost but the lives of all his fellow workers.

There has been an unfortunate tendency on the part of the miners to believe that every attempt at discipline on the part of the operators was merely an attempt to make more money. The belief was mistaken, of course, and fortunately it is disappearing with the increased effort to prevent accidents, known as the safety-first movement, but unfortunately there is still in many places a tendency to resist the proper punishment of a miner who violates regulations. This tendency ought to be condemned, not only by the mine operators, as it is, but by every miner; and there is no way in which this condemnation could be made more strongly evident than by punishment by the miners themselves, through their organizations, of every violation of a regulation intended to promote safety. When some such action comes, the miners' organizations will occupy a new place in our esteem.

The Layland, W. Va., Mine Disaster

A Description of the Mine, the Cause of the Disaster, and the Work of the Rescuers

Written for The Colliery Engineer

THE disaster at the Layland mine of the New River and Pocahontas Consolidated Coal Co., in the New River district of West Virginia, on March 2, occurred in a mine that was considered an especially safe one. The natural conditions were exceptionally good, and the general arrangements of the mine, the safeguards provided by the company, and the care exercised by the officials, were such as to mark it as one of the safest mines in the state.

The Layland mine consists of three water-level openings on Chestnut Knob Fork of Laurel Creek. The Chestnut Knob Fork ravine at the mine openings has a general course of a little east of north. The tipple, through which the coal from all three openings passes, is located south of No. 1 opening. The three drift mouths, one of which is shown in the illustration, were driven parallel to each other on a course of about north 60 degrees east; the three main headings being about 2,000 feet apart.

No. 3. Drift Mouth, Layland Mine

From the No. 3 heading, the most northern one driven from the surface, at a point about 800 feet inside the drift mouth, an entry was driven due north, called the "Main Tunnel." From this, two main entries, known as Nos. 4 and 5, parallel to Nos. 1, 2, and 3, were opened at distances of 2,000 feet apart.

In all accounts of the accident it was stated that it occurred in No. 3 mine. This is due to the fact that locally each of the three openings is called a mine, while actually all the workings are in the same seam and are connected, and therefore constitute one mine. The coal from all three openings is delivered to a track on the surface, running from No. 3 opening to the tipple, which is equipped with a Link-Belt retarding conveyer, adjusted for a capacity of 2,500 tons per day.

The seam worked is locally known as the Fire Creek seam, being the middle of the three seams usually found in the New River series; viz., the Sewell, Fire Creek, and Beckley.

The Fire Creek seam at the Layland mine ranges from 3 feet 6 inches to 4 feet in thickness, and has an exceptionally good top. An analysis of the coal shows the fol-

lowing composition: Moisture, 1.24; volatile matter, 18.81; fixed carbon, 75.41; ash, 4.54.

The mine is worked throughout on the pillar-and-stall system and pick mining is general, little machine mining being done. The haulage, both gathering and on main roads, is done by electric locomotives, Westinghouse, Jeffrey, and General Electric locomotives being used.

The ventilation of the mine is provided for by two Clifford-Capell blowing fans, each of 400,000 cubic feet per minute capacity. Both, however, are geared down to less than half their rated capacity, but with their reduced speed they provide abundant ventilation and very much more than is required by the law.

While the coal seam ranges from 3 feet 6 inches to 4 feet thick, the haulage roads have a height of about 7 feet, sufficient top rock being blown down to afford this height. Top rock was similarly blown down in main airways, so as to make them of sufficient area and proper shape to produce best results. The view shown of the mouth of No. 3 is typical of the systematic and substantial arrangement of the mine throughout. An inspection of the working map showed an excellently laid out mine, worked according to the most approved system for pillar-and-stall work.

No explosive gas has ever been encountered in the mine, before or since the explosion. The blowing down of top along the haulage roads and in airways is done by company work and naturally dynamite is used for this purpose, but no dynamite is ever sold to any of the employes, and its use in shooting the coal down was and is forbidden.

The mine was not considered a dusty or dry mine, though there were dry spots in the mine, and the coal was of a friable nature. The investigations made showed that the explosion originated in the third left heading off the Main Tunnel, which, as stated before, was driven due north from No. 3 Main Heading.

At a point on the third left heading, between 800 and 900 feet from the Main Tunnel, a breakthrough was being driven near the face. A hole about 3 feet 6 inches was driven in the coal and the miner is believed to have used a charge of dynamite which he must have obtained surreptitiously, or a mixed charge of dynamite and black powder. The thickness of the coal to be cut through was only 4 feet, or 4 feet 3 inches, and the powerful explosive used blew through the 6 inches or 9 inches of coal beyond the heel of the hole. The point where the drill hole was started was the wettest point in the mine. The entry leading to it had a rising grade of about 12 per cent. for about 400 feet. It was then level for about 200 feet; then had a dip of 3 per cent. or 4 per cent. to the face. From the face back, a distance of 150 feet, the tracks were continually wet. However, the point where the shot blew through was dry, and it is believed that the tremendous explosion caused by the dynamite, practically blowing in every direction, originated a dust explosion that jumped over the damp places and spread through practically all the workings off No. 3 opening, or what is locally called No. 3 mine.

While the force of the explosion was sufficient to blow out practically all the stoppings in No. 3 section, it did not cause any great falls of roof, and did not affect any of the men employed in Nos. 1 and 2 sections, notwithstanding these sections were, as stated before, in the same seam and connected consecutively with No. 3.

At the time of the explosion there were about 300 men employed inside in all the workings. Of these, 111 were killed, including the miner whose shot is believed to have originated the explosion. His body was found with the head blown off. Not more than half a dozen of the bodies taken out of the mine, including the one whose head had been blown off, showed effects of sufficient bodily injury to cause death. Some had faces and hands burned, but not their bodies, so that it is probable that most of the men killed met death through the effect of the afterdamp or carbon monoxide. One man, a negro, who was delivering groceries in the village, happened to be passing the mouth of No. 3 mine at the moment that the explosion occurred, and he was blown against a post with such force as to instantly kill him.

Practically no damage was done to the fan, although the timbering for 100 feet inside the mouth of No. 3 opening, and a part of the masonry facing shown in the picture, were blown down.

The explosion occurred on the morning of March 2, at 8:25. Immediately following the accident, gangs of men under the direction of the coal company's superintendent, started rescue and repair work.

The general superintendent was en route from Philadelphia to Charleston when knowledge of the disaster reached him. Leaving the train at Quinnimont, he arrived at Layland less than 3 hours after the occurrence, and at once assumed general direction of all work, continuing his supervision until the end.

The District State Mine Inspector having immediate charge of the territory, with an inspector from adjoining territory, arrived during the afternoon, and the Chief of the Department of Mines of West Virginia, together with four of his district inspectors, arrived during the evening. The chief immediately put himself and the district inspectors in touch with the coal company's officials, and they each and all showed untiring energy and were of great assistance in the rescue work.

The United States Bureau of Mines Car No. 8, which at the time of the explosion was on a branch road near Glenalum, W. Va., received word of the explosion at 12:15 p. m. Through the cooperation of the Norfolk & Western, and Chesapeake & Ohio Railroad officials, the car was sent to the mine, making a record run, and at 10:30 p. m. the crew reported to the Chief of the Department of Mines of West

Virginia and the coal company officials, to assist in the work of exploration and rescue.

At the request of the United States Bureau of Mines, the oxygen apparatus crew of 11 men of the United States Coal and Coke Co., of Gary, W. Va., reported to the Chief of the Bureau of Mines Rescue Operations and arrived with him on Wednesday afternoon—the day following the explosion.

In less than a half hour after the explosion occurred, under the direction of the coal company's officials, the emergency repairs had been made and the fan was forcing air into the outer sections of the mine. By reason of the prompt repairs to the fan and the restoration of ventilation along the outer part of the main air-course, seven men from Nos. 4 and 5 left headings either walked or were assisted by the advance rescue party to escape from an entry which had not been affected by the explosion.

As exploration developed the fact that the main entry had but few falls, all of which were comparatively light, with no material amount of wreckage, it was decided on Friday night to reverse the air-current, so as to permit the use of the haulage road. The changes required in connection with reversing the fan necessitated the withdrawal of all men engaged in rescue work at that time.

On Saturday morning while these changes were in process of completion, the fan having been stopped for a number of hours, the atmosphere in No. 3 main haulage road had cleared sufficiently to permit five men to walk out of the mine unassisted. These men had built a barricade near the face of No. 9 left heading 500 feet from the main entry to protect themselves from afterdamp, and upon coming to the surface they reported "more men inside at No. 10 left, off the main entry."

Responding to the information thus obtained, representatives of the United States Bureau of Mines, the company's General Superintendent, and the Chief of the Department of Mines of West Virginia, together with some of his inspectors, went into the mine and found in No. 10 left, 41 surviving men, and they, together with others who followed, assisted in bringing out those who had been entombed, the first man actually reaching the entombed men being one of the West Virginia district inspectors.

Most of the rescued men were quite weak and two of them had to be carried out on stretchers. All of them, on reaching the surface, were carefully wrapped in blankets and taken to a dispensary for proper care and medical attention.

These men had built barricades in the entry near its mouth, and later on barricades 500 feet in, and thus protected themselves from the deadly afterdamp.

The 111 men who met death in the mine were found in various parts of the workings off No. 3 main entry, and the main entry or tunnel driven due north from that entry.

The intelligence of the five men from the No. 9 left heading and of the 41 men in the No. 10 left heading, in the building of barricades and in using splendid judgment and patience under extraordinarily trying circumstances, undoubtedly saved their lives, and is evidence that the leaders among them were men of more than average force and intelligence.

Published descriptions of the mine disaster appear to have given rise to contradictory statements in reference to the rescue work, which, when fairly studied from the viewpoint of the results accomplished, indicates that there could have been no hasty judgment interfering with the apparent well-organized system of pursuing the work in hand.

The work of the West Virginia Mining Department, the representatives of the Federal Bureau of Mines, as well as the company officials deserve well-merited praise for the work in which they all joined in directing. But to the various mining companies' employes of the adjoining mines, as well as to employes from other New River companies' mines who entered into the work of recovery of employes whose lives were lost and the work of repair and reconstruction of the property damaged, in volunteering as well as carrying on the work, is due the credit too often overlooked when it should be properly appreciated and commended.

Lehigh Valley Mine Drainage Tunnel

Through a tunnel nearly 4 miles long the Lehigh Valley Coal Co. will drain the mine water from its Hazleton, East Sugar Loaf, and Stockton (Coxe) mines, near Hazleton, Pa.

At the present time the Wharton and Mammoth workings at the Hazleton No. 1 slope contain a considerable quantity of water. A 600-foot tunnel will be driven from the eighth level of the slope in the Buck Mountain seam to the Wharton. This will also tap the Mammoth workings.

The main tunnel will also be driven from the same level and on a course of about N 26° W for 15,600 feet, then the remaining distance at about N 15° W to the water level of the Little Nescopeck Creek in the Conyngham Valley.

The tunnel will be 9 feet wide and 7 feet high with a concrete drainage ditch to conduct the water, which will average about 5,000 gallons per minute. The grade of the tunnel will be .125 per cent.

The eighth level of the No. 1 slope is 990 feet above tide and about 650 feet below the surface. At a point 8,400 feet from the Buck Mountain seam, along the line of the tunnel, the surface dips to a point only 500 feet above the tunnel. It is at this point that it is expected that the contractor will sink a shaft. This would promote ventilation and enable work to proceed at four different places at the same time.

In the future an extension will be made from the No. 1 slope to the Spring Mountain collieries. This will then drain that entire district.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Air for Methane Combustion

Editor The Colliery Engineer:

SIR:—The question submitted by Mr. Philip Davis, in the April issue of THE COLLIERY ENGINEER, should be worked as follows:

The chemical equation expressing the reaction which takes place in an explosion of methane is

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

Calculating the molecular weights of these substances, and placing these in the form of the equation, we obtain

$$16 + 64 = 44 + 36 = 80.$$

This expression shows that 16 parts by weight of methane act with 64 parts of oxygen to produce 44 parts by weight of carbon dioxide and 36 parts of water.

By proportion,

165 pounds of CO_2 : number of pounds of O_2 = 44 parts of CO_2 : 64 parts of O_2.

Therefore, the number of pounds of $O_2 = (64 \times 165) \div 44 = 240$ pounds.

The weight of 1 cubic foot of air at the given temperature and pressure is found by use of the formula $W = 1.3253 B \div (460 + t)$, in which

W = weight of 1 cubic foot of air, in pounds;

B = barometer reading, in inches of mercury;

t = reading on Fahrenheit thermometer.

Substituting the barometer and thermometer readings given,

$$W = (1.3253 \times 29.9) \div (460 + 50) = .07785 \text{ pound.}$$

The specific gravity of oxygen is 1.1056, so the weight of 1 cubic foot of oxygen under the given conditions is

$$1.1056 \times .07785 = .08604 \text{ pound.}$$

Since there were 240 pounds of oxygen required for the explosion of the methane, and since each cubic foot of oxygen weighed .08604 pound, there were

$$240 \div .08604 = 2{,}782.4 \text{ cubic feet of oxygen.}$$

The composition of atmospheric air is roughly 79 parts of nitrogen and 21 parts of oxygen, and for general calculations the proportion is taken as 4:1. Therefore, considering the oxygen as constituting $\frac{1}{5}$ of the air, the volume of air required for the explosion of the methane, to produce 165 pounds of carbon dioxide is

$$5 \times 2{,}782.4 \text{ cubic feet} = 13{,}722 \text{ cubic feet.}$$

E. C. LEE

Instructor, Illinois Miners' and Mechanics' Institutes.

Piping System

Editor The Colliery Engineer:

SIR:—I am enclosing a skeleton outline of the piping system in a section of No. 69 mine of the Vandalia Coal Co. I think the arrangement extremely interesting.

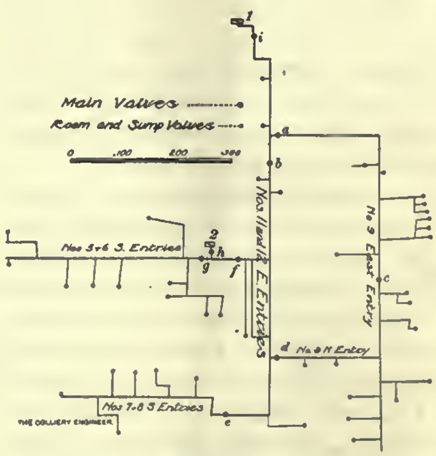


FIG. 1. PLAN OF PIPING

As will be noted, pump *1* which has a free discharge, is situated at the end of No. 12 entry, and the piping is so arranged that this one pump will take the water from the entire section. At the present time, valve *a* is open and valve *b* closed. This enables the pump to draw from all the workings off No. 9 entry down to valve *c*. The main line is 3 inches in diameter, the branches into the rooms are 2 inches. Still more water can be handled by opening valve *c* and closing valve *d*.

Pump *2* has a 4-inch main line with 2-inch branches and discharges through a bore hole to the surface. By the manipulation of the valves it is obvious how one pump can do the work of both in case of a breakdown. Both are motor driven.

J. W. MILBOURNE

Seelyville, Ind.

Forced Draft

Editor The Colliery Engineer:

SIR:—The writer saw the inquiry of Mine Manager in the March issue of THE COLLIERY ENGINEER, and, having had some experience with both steam and turbine blowers, takes pleasure in telling you of the results of our practice.

On our boilers, one a 300-horsepower Maxim-type water-tube boiler and the other a 250-horsepower Heine water-tube boiler, as originally installed, steam jet blowers were provided. Grates of the shaking type with something more than 20 per cent. air space were installed in the Maxim boiler. I will tell you of our results with the Maxim boiler because I have run it with both the large and small air-space grates and with both steam jet and turbine blowers. The tests made were ordinary working tests and both were made by the same men and under similar conditions.

First Test.—Boiler equipped with steam jet blowers and 20 per cent. air space in shaking grates.

Water evaporated from and at 212° per pound combustible, 8.57 pounds. Coal burned per square foot grate surface per hour, 24.33 pounds.

In this test, there was a lot of unburned coal in the ashes. The

openings in the grate were so large that the small pieces of coal would drop through unburned. This accounts for a great deal of the coal burned in the test.

Second Test.—Boiler equipped with 10 per cent. air-space dumping grates and turbine blowers.

Water evaporated from and at 212° per pound combustible, 10.56 pounds. Coal burned per square foot grate surface per hour, 14.44 pounds.

No. 3 buckwheat or birdseye anthracite was used.

The turbine blowers are really the ideal unit for forced draft in a boiler installation of one or many units. Of course some sort of a central fan installation would serve the same purpose as the individual turbine blowers, but the great advantage of the latter is that the whole plant is not crippled when one goes bad, if such a thing happens.

Our turbine blowers require the minimum of attention, and, so far, we have not expended one cent on repairs. While we have made no experiments on their steam consumption compared to the steam jet blowers, we feel that there is a most marked saving of steam.

From our experience, we know that the essentials for the successful burning of any fine anthracite coal are small percentage of air space in the grates, a large amount of grate surface in relation to the heating surface, and high ash pit pressure.

SUPERINTENDENT

Electric Haulage Problem

Editor The Colliery Engineer:

SIR:—Will you kindly help me out on this haulage problem?

The coal company I am working for as hoisting engineer is going to install an electric haulage. A 13-ton electric locomotive will receive a train of 30 cars weighing, when loaded, 5,000 pounds each, at a siding inside the mine, to be delivered at the tipple about ½ mile distant from the mine. About 100 feet from where the locomotive will receive the loaded cars it will begin to climb a 3-per-cent. grade which is 1,100 feet long. The remainder of the distance to the tipple is about level. There being no other load on this generator, for about ⅘ of the time it will run with only a friction load.

What size 250-volt direct-current generator will be required to handle this load? D. L.

The above problem is impossible with the conditions as stated. The tractive force of a locomotive, that is the tendency which it has to move forward because of the turning of the wheels, is figured for steady running at 20 per cent. of its weight. In this case the tractive effort of a 13-ton locomotive on a level track would be 5,200 pounds. In going up a grade of 3 per cent. a force of 780 pounds would be required to propel the locomotive itself. There is, therefore, left a force of 4,420 pounds to pull the train and that is available as drawbar pull.

To pull a mine car on a level track requires a force of approximately 30 pounds per ton. On a 3-per-cent. grade there will be added to this a grade resistance of 60 pounds per ton, making the total resistance 90 pounds per ton. Dividing 4,420 by 90 we find that the locomotive can pull up this 3-per-cent. grade a load of 49 tons. Dividing 49 by 2½, the weight of a car in tons, we find that that the locomotive can pull about 20 cars.

The conditions here, however, are very severe, as a part of the trip will be going up the grade before full speed has been reached. Therefore, it is very doubtful if the locomotive would pull 20 cars.

Assuming that you use a 13-ton locomotive with this smaller train, the current consumption would be found as follows: It is a practice of manufacturers to give their locomotives a power of about 10 horsepower per ton or 130 horsepower for a 13-ton locomotive. This is equivalent to 97 kilowatts, which at 250 volts requires 390 amperes. Allowing for losses in the transmission and motor of 10 per cent. each, it would be necessary to generate about 120 kilowatts. Probably the generator would be run at a voltage in the neighborhood of 300 to make up for this loss.

To handle the trip of 30 cars would require a locomotive weighing in the neighborhood of 20 tons. This, if worked to its capacity, would require about 600 amperes. —EDITOR.

Sewage Disposal

Editor The Colliery Engineer:

SIR:—Should I be asking too much to have discussed in the columns of your valuable paper a sewage disposal or septic tank sufficient to take care of one house of some assumed size?

A SUBSCRIBER

Mine Management

Editor The Colliery Engineer:

SIR:—Will some of your readers answer the following question, which has been a matter of discussion in this district:

How would you develop, arrange, equip, officer, and manage a gaseous and dusty mine to insure freedom from accumulation of gas and dust and the danger incident thereto, keeping in view safety and economy? READER

Greensburgh, Pa.

Instruction for Miners

A practical miners' course is given by the University of Kentucky, extending from April 5 to May 29. This is intended especially for miners, mine foremen, and superintendents, but is open to any who may be interested in mining. The course deals with methods of mining, the use of machinery, gases, mine ventilation, drainage, fire, explosions, rescue work, surveying and map drawing, and the Kentucky mining law. The session closes just before the state mine examination. Between 40 and 50 attended the course last year.

Illinois Mining Institute

The summer meeting of the institute will be held at Danville, Ill., May 27, 28, and 29.

Answers to Examination Questions

Questions Selected From Those Asked at Examinations for Mine Inspector, Mine Foreman, and Fire Boss in Various States in 1914

Ques. 1.—Describe the occurrence of firedamp and blackdamp, the dangers arising from them, and how each may be recognized.

Ans.—Firedamp may be expected in those parts of the mine where the air-current is sluggish and not sufficient in volume to carry away the gas as fast as it is given off by the face. Such places would be in old workings, and in both rooms and entries inby the last breakthrough. It is often found in the neighborhood of spars or clay veins or of dykes of volcanic rock cutting across the measures, and particularly just after cutting through them, being prevented from escaping by the clay or rock. Firedamp is lighter than air and has a tendency to rise to the roof, but in so doing it mixes mechanically with the air, assisting thereby the natural process of diffusion. If given off near the roof, the gas will remain there until it diffuses uniformly through the place or is removed by the air-currents. Gas is commonly found in cavities in the roofs of rooms and entries and above the falls in old workings and in pillar workings where the air-current passes underneath (does not rise into the cavity or fall) and where it is given off more rapidly than diffusion can mix it with the mine air.

Blackdamp, which is largely formed by the oxidation of the coal and by the absorption of the oxygen of the air by the coal, is commonly found in old workings and other places where the ventilation is poor or is wanting. As blackdamp consists of from 5 to 15 per cent. of carbon dioxide and 95 to 85 per cent. of nitrogen, it is sometimes a little lighter than air. The higher the percentage of carbon dioxide the heavier the blackdamp and the greater its tendency to remain near the floor. Under usual conditions, it is distributed uniformly through the air of a place. Blackdamp, mixed with other gases and particularly carbon monoxide, results from mine and gob fires, coal dust, explosions, etc.; that is, it is a constituent of afterdamps of all kinds. The small amounts of blackdamp given off by the face are not of importance unless ventilation is entirely wanting.

Firedamp is commonly detected by the cap it makes upon the flame of a safety lamp; about 2 per cent. being the lowest amount the average competent observer can determine. Special forms of lamps or special devices attached to the ordinary forms of lamps are used to detect 1 per cent. or less. Since much less than 1 per cent. of the gas is dangerous in the presence of dry and explosive coal dust, and since this small amount cannot be detected by safety lamps, it is becoming the custom at large mines to employ a chemist to analyze the return air that the percentage of methane in it may be accurately known. The ventilation, as a whole, is regulated upon the results of the analyses, but fire bosses are employed as usual to watch the face, etc. Some old miners claim that they can detect firedamp by a taste like that of apples and a peculiar smell. As pure methane is tasteless and odorless, such sensations must be due to some other gas mixed with the firedamp. It is also claimed that, under certain conditions, firedamp may be seen, its appearance resembling somewhat the shimmering of the air due to so-called heat waves on a warm summer day. This is possible owing to the difference in the refraction of the rays of light from a lamp in passing through layers of firedamp of different densities.

Blackdamp is detected by its action upon the flame of a lamp, which burns more and more dimly, as the percentage of this gas increases, until it is finally extinguished. Although blackdamp high in carbon dioxide has a direct effect, by reason of its cooling action, in dimming and extinguishing a flame, yet the effects are more due to a lack of the oxygen necessary to support combustion than to the presence of blackdamp. An ordinary oil lamp will be extinguished when the oxygen in the air has been reduced to, say, 17 per cent., but an acetylene lamp will burn until the oxygen is reduced to about 12 per cent.

Mixtures containing 50 to 60 per cent. of firedamp, about 40 per cent. of blackdamp, and 1 to 2 per cent. of oxygen are sometimes found in old workings and are extremely dangerous under certain conditions. The flame of the safety lamp is instantly extinguished in such mixtures without showing the cap due to the large amount of firedamp present. The gas would, naturally, be reported as blackdamp. However, should there be a reduction in the pressure of the atmosphere due to a fall in the barometer or should any other cause force this gas into the airways, it will, when mixed

with air, produce explosive conditions.

Ques. 2.—If a water gauge placed in a door 4 feet 6 inches high and 5 feet wide showed a reading of 2.7 inches, what was the total pressure on the door?

Ans.—Since 1 inch of water gauge is equal to a pressure of 5.2 pounds per square foot, 2.7 inches water gauge is equal to $5.2 \times 2.7 = 14.04$ pounds per square foot. The area of the door is $4.5 \times 5 = 22.5$ square feet. Hence, the total pressure upon the door is *area* × *unit pressure* = 22.5 × 14.04 = 315.9 pounds.

Ques. 3.—What are carbon monoxide and carbon dioxide? Give their chemical symbols.

Ans.—Carbon monoxide is a colorless, odorless, tasteless, explosive, and highly poisonous gas, composed of 1 atom each of carbon and oxygen as shown by its symbol, CO. It is formed by the incomplete combustion of carbon or compounds of carbon where there is not sufficient oxygen for it or them to burn to carbon dioxide. It is commonly found in the afterdamp of coal dust explosions, in the gases of gob and mine fires, and in the gases given off by explosives, particularly where coal dust is used for tamping.

Carbon dioxide is a colorless, odorless, tasteless, non-explosive, and non-poisonous gas composed of 1 atom of carbon and 2 of oxygen, as shown by its symbol CO_2. It extinguishes a flame by depriving it of oxygen and, in sufficient quantities, causes death by suffocation by excluding oxygen from the lungs. It is given off by the face of the coal and is found in afterdamp of firedamp and coal-dust explosions, in the gases from gob and mine fires, in the gases from explosives, etc.

Ques. 4.—What are the area of cross-section and contents of a cylinder 12 inches in diameter and 18 inches long?

Ans.—The area of the cylinder is $12^2 \times .7854 = 113.1$ square inches, very nearly. The contents of the cylinder is equal to area × length = 113.1 × 18 = 2,035.8 cubic inches.

Ques. 5.—Why is it necessary to leave larger pillars in some mines than in others?

Ans.—The greater the distance of the seam below the surface, the larger must be the pillars in order to sustain the greater weight of the overlying rocks. The thicker the seam, the larger must be the pillars to sustain the same weight of overburden. The reason for this is apparent when it is recalled that, owing to bending, a tall pole will not support the same weight as a short one of the same diameter. The longer the pillars are to remain, the larger must they be to resist the weathering action of the air and the effects of long-applied pressure. Pillars that are left as permanent roof supports are much larger than those that will be pulled some time during the life of the mine and very much larger than those that will be drawn as soon as a set of rooms reaches their limit; say, within a year or two. The features named above, namely, depth of the seam below the surface, the thickness of the seam, and the time the workings must remain open, have to be considered in all mines in determining the thickness of the pillars and the width of the rooms.

In some mines, that is, locally, it may be necessary to take account of the strength or weakness of roof or floor in determining relative width of opening to thickness of pillar. Thus, in a mine where the roof is hard and unyielding and the floor is very soft, larger pillars must be left than where opposite conditions prevail, in order to prevent the weight of the overburden forcing the pillars into the bottom and bringing on a squeeze; that is, with a soft bottom, the pillars must be larger, that the weight may be distributed over a greater area.

Larger pillars are required in pitching than in flat seams, where the rooms and entries are wide than where they are narrow, and where the coal is soft and friable than where it is tough, hard, and firm.

Ques. 6.—An airway whose cross-section is 6½ feet at the top, 8 feet at the bottom, 4 feet high on one side and 7 feet high on the other, is passing 8,000 cubic feet of air per minute; what is the velocity of the air in feet per minute?

Ans.—As none of the four angles are given, the exact shape of the airway is unknown, and its angles may be sharp or flat, or one may be a right angle. The last case is the simplest and it will be assumed that the 7-foot side is perpendicular to the 6 feet 6 inches (6.5 feet) top. The cross-section may, then, be considered as being made up of two triangles, (*a*) a right-angled triangle whose sides are 6.5 and 7 feet, respectively, and (*b*) an oblique-angled triangle two of whose sides are those of the airway, or 4 feet and 8 feet, and the third side is the hypotenuse of the right-angled triangle (*a*). The area of the airway is the sum of the areas of the triangles.

(*a*) The area of this right-angled triangle is equal to one-half the product of its sides, or to $(6.5 \times 7) \div 2 = 22.75$ square feet. The hypotenuse of this triangle is equal to the square root of the sum of the squares of its sides, or to

$$\sqrt{6.5^2+7^2}=9.55 \text{ feet}$$

(*b*) The sides of this oblique-angled triangle are, respectively, 4, 8, and 9.55 feet, and its area may be found from the formula

$$A=\sqrt{p(p-a)(p-b)(p-c)},$$

in which

$p = \frac{1}{2}$ the sum of the sides $= \frac{1}{2}(4+8+9.55) = 10.775$ and the sides are a, b, and c, and

$$p-a=10.775-4=6.775$$
$$p-b=10.775-8=2.775;$$
$$p-c=10.775-9.55=1.225.$$

Substituting in the formula,

$$A=\sqrt{10.775 \times 6.775 \times 2.775 \times 1.225}$$
$$=15.75 \text{ square feet}$$

(*c*) The total area of the airway is, thence, equal to $22.75 + 15.75 = 38.50$ square feet.

(*d*) The velocity of the air-current is equal to the volume, in cubic feet per minute, divided by the area of the airway in square feet and is $8{,}000 \div 38.5 = 208$ feet per minute, very nearly.

QUES. 7.—What are the essential features to be observed in building and maintaining roads to secure the safe, speedy, and economical handling of the coal?

ANS.—The roads should be as straight as possible with few curves and those of large radius with the proper elevation on the outer rail to offset the centrifugal force. Where motors are used, the rail should weigh not less than 10 pounds per yard per ton of weight on a single driver; thus, a four-wheeled 20-ton motor which has $20 \div 4 = 5$ tons of weight on each driver will require the use of a rail weighing not less than $10 \times 5 = 50$ pounds per yard. Many of the larger companies find it economical to use 70-pound rails for a motor of this size. The track should be firm and should not give under the weight of the trip; this necessitates the use of large ties spaced not too far apart which must be properly supported upon good ballast well tamped beneath them. Where possible, the grade should be in favor of the loaded trip, but this is not a matter of prime importance in comparison with keeping the roadbed and rolling stock in good shape, as grades can be overcome by the use of the proper kind of motor or rope-haulage system.

The track should be laid as close to one side of the entry as possible so that ample clearance is offered on the other side, that track workers may not be injured by a passing trip. This requires that the entries should be driven straight which may be done by employing an engineer to place the necessary sights as a guide for the entry drivers. If the sight plugs are so placed that they come over one of the rails, they will materially help the track layers in their work. The clearance, noted above, should be maintained on one side of the entry and not first on one side and then on the other. Refuge holes should be provided at regular intervals and it is a good plan to have them whitewashed or to hang an incandescent electric light in front of them. These refuge holes should be kept clear of all kinds of dirt and rubbish, and they may be the necks of rooms, breakthroughs, or specially driven places carried in not less than 4 feet from the rib. A ditch, which must be kept clean of rubbish, may be carried along one rib where the mine is wet. Where switches are used, they should have point rails and frogs similar to those used on surface roads; stub switches are to be avoided.

QUES. 8.—What size of pipe should be used to transmit 800 cubic feet of air per minute a distance of 2,500 feet, the initial pressure being 100 pounds per square inch, and the plant being located 4,000 feet above sea level where the reading of the barometer is 26 inches under normal conditions?

ANS.—Since the weight of a cubic inch of mercury is equal to .49 pound, the pressure of the atmosphere corresponding to a height of the barometer of 26 inches is $.49 \times 26 = 12.74$ pounds per square inch.

Since the initial, or gauge, pressure is 100 pounds, the total pressure upon the air will be $12.74 + 100 = 112.74$ pounds per square inch. To secure this total pressure, the air must be compressed $\frac{112.74}{12.74} = 8.85$ atmospheres.

Since the volume of the air is proportional to the pressure, it will, after being compressed, occupy a space of $800 \div 8.85 = 90.4$ cubic feet $= 90.4 \times 1{,}728 = 156{,}211.2$ cubic inches.

The area of the pipe will be equal to the volume of air passing per minute divided by the velocity per minute. If the velocity be assumed at 2,000 feet $= 2{,}000 \times 12 = 24{,}000$ inches per minute, the area of the pipe will be $156{,}211.2 \div 24{,}000 = 6.5088$ square inches. The diameter of the pipe will be equal to

$$\sqrt{\frac{6.5088}{.7854}} = 2.88, \text{ say, } 3 \text{ inches}$$

QUES. 9.—What should be done in case of accident to a ventilating fan or its driving machinery?

ANS.—Get the men out of the mine as soon as word or signal will reach them, keeping the fan turning if possible, even though slowly, until this is done. The men can usually be gotten from the workings before it is possible to install temporary means for keeping up the air circulation. If the material is on hand, it may be well in special cases to fit together a number of lengths of steam pipe so that live steam can be introduced into the upcast and as near to its bottom as possible. If pipe is not at hand and brattice cloth is available, a wind cowl may be built to force whatever air may be blowing down the downcast shaft.

QUES. 10.—(*a*) If the atmospheric pressure should fall suddenly, what would be the effect upon the ventilation in a mine generating explosive gas?

(*b*) Should you be notified of a fall in the atmospheric pressure and you were in charge, what orders would you give?

ANS.—(*a*) When the pressure of the atmosphere is reduced in a mine, more gas than usual will escape from the face, from blowers, and from the old workings. As the gas issuing from the face and from blowers is under a high pressure (often from 10 to 40 atmospheres, or 150 to 600 pounds per square inch) but a short distance back in the solid, although only a little above that of the air at the point of its escape into the mine, a very heavy fall in the barometer does not have nearly the same effect in increasing the outflow of gas from these sources as it does from the old workings where the gas is under ordinary atmospheric pressure. Other things being equal, the greater the area of the old workings the greater will be the volume of firedamp forced into the airways by a fall of the barometer. From this it follows that it is a good policy, although disputed, to seal off the old workings with permanent, gas-tight stoppings. This can readily be done if some panel system of mining is used wherein each panel is connected to the main airways only by the two or three entries used to develop it.

It should be remembered that an increase in the outflow of gas always happens several hours before the barometer falls; in other words, the barometer tells what has happened and not what is going to happen. So it is possible for a sudden fall in the barometer to take place just before the outflow of gas decreases and not before it increases, which would be the case were the barometer as sensitive to atmospheric changes as is a large body of standing gas in old workings. It is now generally considered that in well-ventilated mines where there are no open old workings full of gas, changes in atmospheric pressure do not so much affect the amount of gas in the workings as the rapidity of working; that is, during the day while coal is being made and fresh faces for the escape of gas are being opened with a rapidity proportional to the output, the outflow of gas gradually becomes greater from the beginning to the end of the day shift and decreases during the night while the mine is idle and is a minimum again the next morning. What were called "barometer warnings" were issued for many years in England but did not have the authority of the Government. They have been dropped within the past two or three years, not only as being useless but dangerous in that they caused a false sense of security.

(*b*) In view of the fact that the trouble is over by the time the barometer falls, nothing can be done to prevent it. Did the fall of the barometer precede instead of follow the increased outflow of gas, it would be possible to speed up the fan; and this is all that it is necessary to do.

While a barometer stationed at a mine is not of particular service in anticipating changes in the amount of gas escaping into the workings, the Daily Weather Maps issued by the Weather Bureau, at Washington, are of value in this connection. These maps show the areas of low barometric pressure for the entire country, and the direction in which these areas are moving. Thus, the map may show an area of low pressure in Arizona which is moving toward Illinois where it will arrive, say, from 36 to 48 hours later. Before the barometer at a mine in the latter state will have recorded the reduction in pressure, increased amounts of gas will have escaped into the workings; but this increase in gas has been foreseen, not by the local barometer, but by the weather map which gave notice of it at least a day in advance.

BOOK REVIEW

A review of the latest books on Mining and related subjects

Report on the Non-Metallic Minerals Used in the Canadian Manufacturing Industries. By Howells Fréchette, M. Sc., Chief of the Non-Metalliferous Deposits Division, Department of Mines of Canada, Ottawa, Mines Branch, No. 305. This book of 199 pages contains a list of the various non-metallic minerals which are used in manufacturing industries, with short descriptions giving special reference to those qualities which make them important for industrial purposes. This is followed in each case by a discussion of the applications of the mineral, the amount used, and the price. This list is followed by a series of 37 tables giving for each manufactured substance in which a mineral is used, the number of firms visited, the number using minerals, the number from whom no information was received, and the amount of each mineral used. Following this is a bibliography which is devoted to the industrial use of minerals. Appendix No. 1 gives the names and addresses of Canadian manufacturers who use minerals, arranged alphabetically under the names of the articles manufactured. Appendix No. 2 gives lists of producers of non-metallic minerals arranged alphabetically under the names of the minerals.

Peat, Lignite, and Coal. Their Value as Fuels for the Production of Gas and Power in the By-Product Recovery Producer. By B. F. Haanel, B. Sc., Chief of Fuels and Fuel Testing Division, Department of Mines of Canada, Ottawa, Mines Branch, No. 299.

Chapter 1 gives a thorough discussion of the digging and handling of peat and its preparation for use as a fuel. Chapter 2 gives chemical analyses of peat and a discussion of its calorific value and the effects of moisture on this value. Chapter 3 is devoted especially to the production of ammonium sulphate, and discusses various plants with relation to the production of this substance. Tables of production in different countries throughout the world are given. Chapter 4 is concerned with by-product recovery plants for the utilization of peat and coal in operation in Europe. Chapter 5 gives a description of a peat burning power plant in Germany. Chapter 6 discusses the feasibility of erecting by-product recovery peat producer-gas power plants in Canada. Chapter 7 discusses lignite and coal with special reference to their use in by-product gas producers. There are 253 pages, 29 plates, 39 drawings, 20 tables.

Coal Land Leases and Royalty Payments. Mr. W. E. Fohl, of Pittsburg, has developed tables "On Present Worth of Serial Payments." These tables will be helpful to those who wish to know whether certain royalties proposed in leases offered by coal lands are equivalent to current acreage prices in the same region. In the case of a property with an estimated productive life of 50 years, there are in contemplation one hundred semiannual payments of royalty, each one of which differs in value to correspond with the length of time it is deferred from the present.

If the tract of land under consideration yielded in royalties $10,000 semiannually for 50 years, and 4 per cent. were the proper interest charge, the tables would show that the present worth of the sum of these one hundred semiannual payments is

$430,982.90. If the tract contains 1,000 acres the present acreage value will be shown as $430.98. The tables can be used not only for finding present worth of a property, but are of especial value in the comparison of leases which differ both in the amount of semiannual income and in the length of time during which this income continues.

Borderland Coal. Published by The Borderland Coal Co., Borderland, W. Va. A 32-page booklet giving a great deal of information about coal in general, and that of the Borderland Coal Co. in particular. It is interestingly written and the photographic illustrations, which are many, give remarkably good ideas of methods of mining and preparing coal.

Report of the Topographic and Geologic Survey Commission of Pennsylvania, for 1913–1914, R. R. Hice, State Geologist, Harrisburg, Pa. The report covers 226 pages, it lists the publications of the United States Geological Survey referring to Pennsylvania and the reports of the State Topographic and Geologic Survey. A report on the South Mountain Copper Development is given in full; general statements of the production of the various minerals in the state, and lastly the production, by counties, of the individual mineral products.

The Story of Pocahontas. Published by The Pocahontas Operators' Association. A booklet of 32 pages describing the excellencies of Pocahontas coal, and incidentally those of the young lady whose name it bears. There are also some excellent features of coal mining in the Pocahontas district.

Coal Resources of District No. 1 of Illinois, by Gilbert H. Cady. Published by the Illinois State Geological Survey, Urbana, Ill., 144 pages, illustrated.

The district is entirely longwall and in its area of 1,700 square miles approximately six billion tons were originally available. Of this amount only about 3 per cent. has been mined or placed beyond recovery by past mining.

The report may be classified in three parts, viz.:

1. General geology. This includes a general description of the Pottsville, Carbondale, and McLeansboro formations in the various fields. Also a description of the structural features and the glaciation in the longwall district.

2. Economic geology. This treats of the various coal beds, their correlation, physical characteristics, chemical composition, etc.

3. Working data. Statistics, drill records, and in some instances geologic sections of the counties in the district. These tabulations are the first official attempts to estimate the coal reserves of northern Illinois.

Michigan Geological and Biological Survey. The Mineral Resources, the Occurrence of Oil and Gas in Michigan, and the Biennial Report of the Director, all published by the Survey under the direction of R. C. Allen, Director, Lansing, Mich.

The volume on Mineral Resources deals with all the minerals mined during 1913, with especial attention to iron and copper.

Statistical tables are given pertaining to the production of coal producing counties.

It is interesting to note that for 1913 the total number of tons of coal mined was 1,138,639 at a cost of $2,250,267.73 or an average cost of $1.97 a ton.

Publication 14 deals with the oil and gas in Michigan and describes the local natural conditions governing their occurrence which as a rule are well known to geologists, but unfortunately the geologic data in different districts are rarely so precise and determinate as to warrant unqualified statements in advance of exploration work.

The plan of the report embraces: (1) An outline of the geology of the Paleozoic formations. (2) A brief discussion of the more prominent theories on the accumulation of oil and gas, but more particularly of the anticlinal theory of accumulation. (3) A history of the explorations by districts or fields with the records of borings. (4) A discussion of the care and regulation of oil and gas wells and an outline of needed legislation relative to deep borings. (5) A brief statement of possibilities of the black shales of Michigan as a source of oil and gas.

Publications Received

Procedure of Establishing a List of Permissible Portable Electric Mine Lamps, U. S. Bureau of Mines, Schedule 6A.

Report of the Committee of Inquiry into the Best Means of Dealing with Coal Dust in Collieries of New South Wales.

The following publications of the United States Geological Survey, Washington, D. C.:

Stratigraphy of the Montana Group, Professional Paper 90–I.

The Cretaceous-Eocene Contact in the Atlantic and Gulf Coast, Professional Paper 90–J.

The History of a Portion of the Yampa River, Professional Paper 90–K.

Inorganic Constituents of Echinoderms, Professional Paper 90–L.

Bulletin 559. The Results of Spirit Leveling in Michigan.

Bulletin 563. The Results of Spirit Leveling in Maryland.

Bulletin 580–L. Salines in the Owens, Searles, and Panamint Basins, southeastern California.

Bulletin 580–P. Publications by Survey Authors on Metals and Nonmetals except Fuels.

Bulletin 589. Calcite Marble and Dolomite, Eastern Vermont.

The following papers on water supply:

Surface Water Supply of the United States, 1911, Paper 312.

Surface Water Supply of the United States, 1912, Paper 331.

Springs of California, Bulletin 338.

Stream Gauging Stations and Publications Relating to Water Resources. Bulletin 340–F.

Stream Gauging Stations and Publications Relating to Water Resources. Bulletin 340–G.

Profile Surveys in Willamette River Basin, Oregon. Bulletin 349.

NEW MINING MACHINERY

Automatic Reclosing Circuit-Breakers

By E. C. Raney

A circuit-breaker is an absolute necessity for the protection of electric circuits against overloads and short circuits. The ordinary circuit-breaker must be closed by an attendant. To meet the desire for a circuit-breaker which will close itself as soon as the overload is removed, thus dispensing with the necessity of an attendant and making it possible to locate circuit-breakers at isolated points, the apparatus, described below, is manufactured by the Automatic Reclosing Circuit-Breaker Co. The breaker is also referred to as a circuit controller for direct current.

The theoretical circuit for such a breaker is shown in Fig. 1. In operation the main contact is held closed by the action of an electromagnet, the plunger of which engages an arm pivoted at P and having a roller at the other end which is moved upward along the surface of a brush arm which carries the main contact brush.

The closing coil is connected in shunt with generator circuit, between points *1* and *2*. At the instant the breaker starts to close, current is taken at full potential, but after the breaker closes, a resistance R_1 is in circuit with the closing coil, the resistance R_1 being of such value as to limit the energy input to the closing coil to a few watts. Suppose a short circuit should occur in the load circuit as at N, an excessive current would then flow through the series coil, and its core C_1 would be drawn upward causing its projection to strike the bell-crank lever, thus breaking the circuit of the closing coil at A and allowing the opening of the main contacts. At the instant that L is moved out of contact with A, the latch H is actuated by the spring S_2 to lock L so as to prevent its return to contact with A, until H

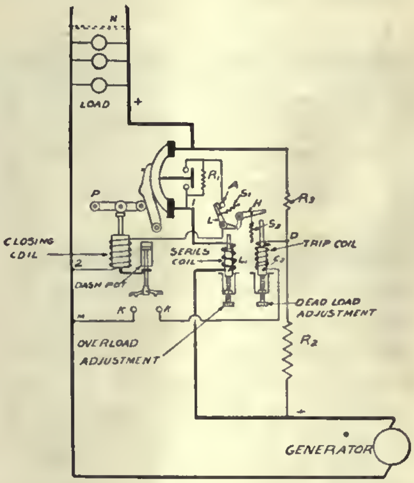


Fig. 1

is thrown out of engagement. It is now evident that the circuit of the closing coil cannot be closed except by the action of the trip coil which controls the latch H.

After the opening of the main contacts two things take place; first, a small index current is permitted to flow around the break through R_2 and R_3; second, the dashpot descends bridging the opening in the trip coil circuit at K. The current now flowing through R_2 has two paths

Fig. 2. Circuit-Breaker, Open Position (100-300 Amperes)

by which it may flow to the opposite or negative side of the line. One of these paths being through trip coil to M, and the other through low resistance R_3 and short circuit at N and negative line to M. Now so long as the load resistance or short-circuit resistance is very low, the greater part of the index current is shunted around the trip coil, but as soon as the short circuit at N is removed, the load resistance will be such that enough current will be forced through the trip coil to cause it to operate and release latch H, thus permitting L to close the operating coil circuit, and the main contacts to be closed by the action of the closing coil.

This breaker has two adjustments, one for overload at which it opens, and the other is called the dead-load adjustment. By the dead-load adjustment is meant the maximum current which can flow at the instant of closing of the breaker.

A dashpot is provided so as to furnish a definite time interval between the opening and closing of the breaker in case of momentary overloads, the object being to give the starting box levers time to return to the "off" position before throwing the power back on the line. This time interval may be readily adjusted to any desired value.

Steel Frame Houses

The general improvement in the standard of living over the country and the attention which is now being given by many of the operators to the welfare of their employes cause a demand for a better class of miners' house than has been erected by most companies in the past. Of course, this desire for a better home is especially apparent in the cases of those miners who own their own homes.

*Electrical Engineer with the Automatic Reclosing Circuit-Breaker Co.

There is need for a house which can be erected at small cost and yet which will be neat in design, healthy to live in, fireproof, and permanent. The Trussed Concrete Steel Co., of Detroit, Mich., has designed a house which seems to meet all of these conditions.

Structural steel made possible the erection of large buildings, but it has proved too heavy, too expensive, and too difficult to handle to permit its adoption as framework for small buildings. The objections seem to have been solved by the forming of steel members, not by rolling, but by pressing them from sheet steel. The difficulty of joining members

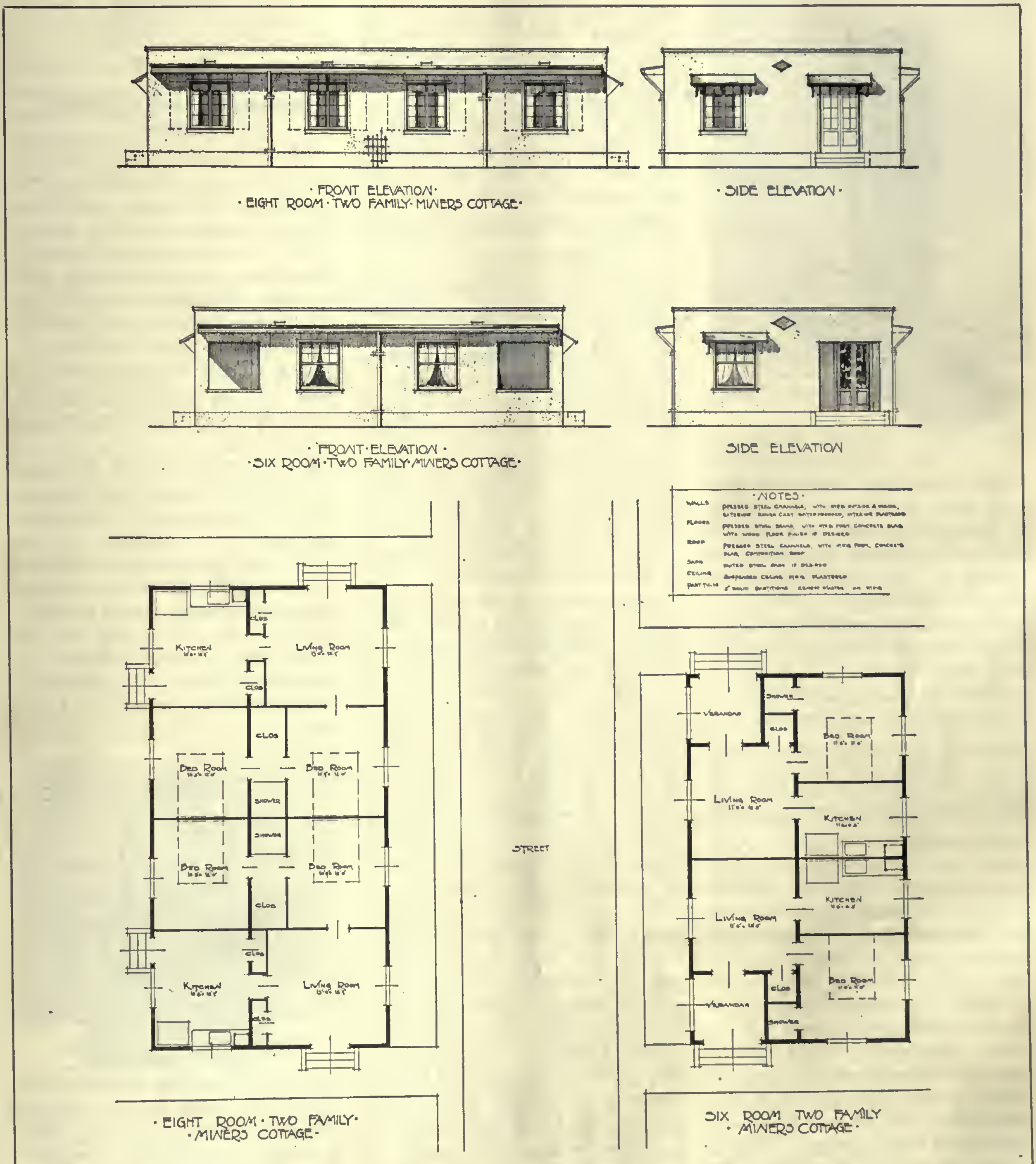


Fig. 3. Steel-Frame Houses for Miners

has been overcome by the contriving of a very simple joint tightened and held by a wedge which requires the use of no tools except a hammer. Of course, the members are formed at the plant according to the particular design used.

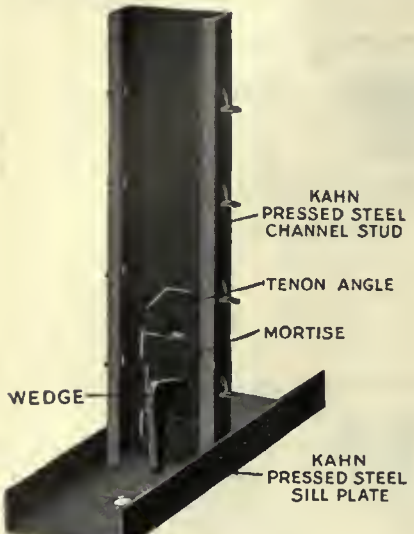


Fig. 4. Joints in Steel-Frame Construction

After the steel frame has been erected, a metal lath known as Hy-Rib is hung onto the prongs of the steel members and these are bent down. The wall or floor is then ready for plastering.

A house with a steel frame, metal lath, plastered inside, and finished with stucco outside, is, of course, fireproof and permanent. Another advantage is the fact that it is vermin-proof and is very easy to keep clean. In fact it is possible to so design a house that the furniture can be moved out and the whole house washed out with a hose. It is very easy to erect, as the members are all cut to shape and require simply to be placed in position and the joints tightened with the wedges. The erection of a building requires only a very short time, and the cost is about the same as that of a wooden building of the same size.

The illustration, Fig. 3, shows plans and elevations of two styles of miners' houses, the character of the construction, and the type of houses which have been developed. Fig. 4 shows the manner of making the joint.

Telephones for Use in Mine Rescue Work

Telephone communication between the advance or rescue party and the outside of the mine, in the case of mine accidents, is one of the features of the daily demonstration of the United States Bureau of Mines rescue crew conducted in connection with the exhibit of the Bureau at the Panama-Pacific Exposition at San Francisco.

This exhibit consists, primarily, of a model mine constructed under the floor of the building, in which are installed appliances, for the promotion of safety and efficiency in mine work.

Twice a day, in response to a telephone message to the effect that an explosion has occurred in the mine, the rescue crew puts on oxygen helmet breathing apparatus and Western Electric mine rescue telephone apparatus, and goes into a glass-walled room located on the main floor of the building.

All the time the rescue crew is in the smoke-filled room and in the mine, they are in constant communication with the outside by means of the telephone equipment.

Each member of the rescue party wears strapped to his throat a small especially designed, transmitter and a watch-case receiver strapped to his ear. This apparatus is connected with a coil of flexible wire, which is carried by the chief of the party on his belt, which pays out as the party advances. The other end of this wire terminates in telephone equipment worn by the person in charge of directing the rescue work at the rear or on the surface.

The reason for this special equipment is that a man, wearing any of the different types of oxygen helmets which cover his mouth, cannot use the ordinary type of telephone transmitter. The throat transmitter furnished transmits speech practically as well as the standard type of telephone instrument and is very small and light, and is provided with a soft rubber cup which assists in holding it firmly against the throat. In the past, many losses of life have occurred to members of rescue parties which unquestionably could have been avoided if there had been some means of communicating with the rear to advise when in need of aid which could easily have been given. The mine-rescue telephone equipment demonstrated at the Exposition satisfies this need.

Reliance Motor-Driven Saws

The Reliance swing saw for cross-cut work is a self-contained unit which can readily be installed by bolting to any convenient wall or post. Two wires supply the power, doing away with line shafting, bolting, etc. An automatic starting box permits quick starting and stopping by means of a knife switch conveniently placed. Current is consumed only when the saw is being used, another saving over constant running line shafting.

These outfits are made in several sizes with both direct and alternating current motors and will cut lumber up to 12 inches thick.

The latest addition to the Reliance line of electric driven saws consists of the above swing saw in combination with an electric rip saw. A double-throw switch controls the operation of either saw and assures the operation of only one saw at one time.

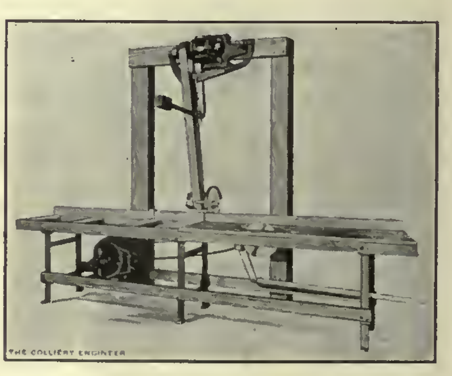


Fig. 5. Reliance Saws

Another attractive feature of this combination is the fact that the two units are independent of each other, it being possible to use them either in combination or at different parts of the work.

Both of these outfits are especially suited for mines, for cutting up timbers and lumber used extensively in mine shaft construction.

Imperial Oxy-Acetylene Equipment

Oxy-acetylene welding and cutting equipment possessing some new exclusive features has recently been placed on the market by the Imperial Brass Mfg. Co., 532 South Racine Avenue, Chicago, a brief description of which follows:

Two points necessary to safe, efficient, economical, and continuous operation of oxy-acetylene equipment are the thorough and uniform mixing of the two gases employed, and close and accurate regulation of both volume and velocity of the gases delivered to the mixing chamber of the torch, with ability to maintain a constant fixed pressure under continuous operating conditions as well as to control a wide range of pressures called for by the various requirements of service.

The safety and efficiency of operation and the life of the equipment are directly dependent upon these points.

Before entering the mixing chamber, the oxygen, under high velocity, passes through a spiral groove which imparts to it a whirling motion. This whirling motion causes it to mix thoroughly with the acetylene so that a uniform mixture is obtained before the gases reach the combustion point. A saving of oxygen is thus obtained and an increased intensity of welding flame and greater efficiency in cutting.

Due to the perfect mixture, the accurate regulation of gases, and the extremely accurate workmanship, the welding flame generated is a long, white, incandescent jet, free from carbons and oxides.

The cutting flame is a very closely confined and accurately proportioned jet of maximum efficiency, which makes a clean, quick, narrow cut with a minimum consumption of gas.

In designing these regulators the aim has been to produce accuracy of control, simplicity and ruggedness of parts, and continuous safe operation.

Pneumelectric Gathering Attachment

The Pneumelectric gathering attachment, as shown in Figs. 6 and 7, consists of a cast-steel drum operated by a small motor, which can be placed on any standard locomotive without interfering in any manner with the operation of the locomotive or occupying space which would otherwise be used for some other purpose. It is mounted on the bumper, where it is the least in the way and yet in the most convenient location for performing its own work.

Fig. 6. End View of Gathering Attachment

The motor is compound wound and ruggedly constructed on account of the rough service demanded about the mines. It is completely enclosed, the winding gears and commutator being fully protected from damage from any source. The armature is vertically mounted in thrust and annular bearings of large dimensions. It drives a spur gear, on the vertical shaft of which is mounted a low flat drum with large flanges. The gearing is completely encased in a base in which is also fixed a band brake for controlling the load on grades.

The drum is keyed to the drive-gear shaft. The weight is carried by a thrust ball bearing directly under the drum. The flanges are 23 inches in diameter and are 2½ inches apart, so that the rope will reel easily and it is not necessary to guide it. It will handle 400 feet of ⅜-inch rope, 700 feet of 5/16-inch, and 1,000 feet of ¼-inch.

The brake, which has a holding capacity proportionate to the power of the motor, is located in the base and consists of a cast-iron drum keyed to the armature shaft. A steel brake band faced with woven asbestos surrounds it, one end of the steel band being attached to an adjustable screw and the other to a lever. The principal dimensions are, height 18 inches and width of base 18½ inches.

Fig. 7. Gathering Attachment in Place on Locomotive

In using the arrangement, the locomotive is run to its furthest point in the usual manner and the rope unwound from the drum until it reaches the car to be handled. The maximum pull is 800 pounds.

TRADE NOTICES

The Vulcan Iron Works, of Wilkes-Barre, Pa., recently installed a 400-horsepower and a 100-horsepower electric hoist at the Henderson Coal Co.'s mines near Canonsburg, Pa. Others recently installed were for the W. J. Rainey Co., W. H. Hughes Co., and the Pennsylvania Coal Co.

The Chicago Pneumatic Tool Co. announce the removal of their New York office to 52 Vanderbilt Avenue, and their Boston office to 185 Pleasant Street.

The Goodman Mfg. Co., of Chicago, has presented to the Department of Mining Engineering of the

University of Illinois, for demonstration and testing purposes, one of the latest models of electric shortwall machines. The machine is so installed in the mining laboratory that any desired load can be thrown on it and the power consumption measured.

Roberts and Schaefer Co.—On June 26, 1914, the Clinchfield Coal Corporation awarded a contract to the Roberts and Schaefer Co., Chicago, for a $50,000 fireproof coal tipple at their No. 2–5 mine at Dante, Va. This structure being similar to the "Marcus" patent coal tipple recently put in operation for them at Hurricane, W. Va. Owing to the war in Europe the coal company suspended operations on the new contract, but have now authorized the immediate construction of this new plant at Dante. The Roberts and Schaefer Co. have also contracted to build for the Lorain Coal and Dock Co., of Columbus, Ohio, a $45,000 Marcus patent coal tipple of steel construction complete with screening and picking facilities for their mine at Craneco, W. Va. They have also been awarded a contract by the Oliphant-Wasson Coal Co., of Vincennes, Ind., for equipment for a Marcus patent coal tipple for their mine at Braceville, Ind.

Unique Trolley Frame

At the Scarbro mine of the New River Co., at Scarbro, W. Va., may be seen a unique device which for

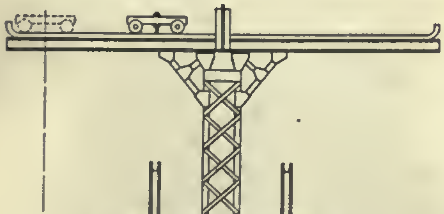


Fig. 1. Trolley Frame

the want of a better name has been called a "trolley frame."

Before it was attached to the tipple, it was always a matter of one or two days to remove a broken or ineffective sheave wheel and replace it with a new one. This was largely due to the lack of effective means in handling these sheaves of great weight, situated as they are over a shaft 400 feet in depth.

After repeated inconveniences of this sort, the engineering department of the company designed the trolley frame, Fig. 1. With a block and tackle attached to the eyebolt in the center of the little four-wheel trolley, the sheave may be easily lifted from its journals and the trolley pushed out on the rails until the sheave is clear of the sides of the tipple, and then lowered. This reduces the work to a matter of 1 or 2 hours, and one such use of the frame pays for its erection.

Catalogs Received

Pneumelectric Machine Co., Syracuse, N. Y. Gathering Attachment for Mine Locomotives, 8 pages. Room Hoists, 15 pages.

Badger Concrete Mixer Co., Milwaukee, Wis. The Badger Mixer, 48 pages.

Kennicott Co., Chicago, Ill. Water, Its Storage, Purification and Measurement for Industrial Purposes, 14 pages.

Kolesch & Co., 138 Fulton Street, New York, N. Y. Special Price List of Kern Drawing Instruments. Circular.

Trussed Concrete Steel Co., Youngstown, Ohio. Kahn Pressed Steel Building Construction, 20 pages.

The Scranton Pump Co., Scranton, Pa. Bulletin No. 101, Scranton Duplex Piston Pumps, 16 pages.

Vulcan Iron Works, Wilkes-Barre, Pa. Electric Hoists, 64 pages.

Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin No. 34–M, Class "O" "Chicago Pneumatic" Steam and Power Driven Compressors, 36 pages.

The Morrow Mfg. Co., Wellston, Ohio. Rescreened Chunks, 32 pages.

Herman Bacharach, 14 Wood Street, Pittsburg, Pa. Hydro Volume and Pressure Recorders, 16 pages.

Erie City Iron Works, Erie, Pa. The "Lentz" Engine, Bulletin No. 4, Engineering Data, Tests and Installations, 42 pages.

A. S. Cameron Steam Pump Works, 11 Broadway, New York, N. Y. Bulletin No. 104, Cameron Pumps, 36 pages. Bulletin No. 151, Cameron Turbine Centrifugal Pumps, 20 pages. Bulletin No. 150, Cameron Centrifugal Pumps, 16 pages. Bulletin No. 152, Cameron Centrifugal Pumps, 8 pages. Bulletin No. 153, Cameron Centrifugal Pumps for House Service, 8 pages. Bulletin No. 300, Cameron Triplex Pumps, 4 pages.

Sanford-Day Iron Works, Knoxville, Tenn. Grease, Greasers, and Greasing for Mine Car Wheels. Circular.

Hazard Mfg. Co., Wilkes-Barre, Pa. Wire Rope, 12 pages.

Spray Engineering Co., 93 Federal Street, Boston, Mass. Washing and Cooling Air for Steam Turbine Generators, 8 pages. Sprays for Cooling Condensing Water, 14 pages.

Armstrong Cork and Insulation Co., Pittsburg, Pa. Nonpareil High Pressure Covering. Circular. Good Furnaces Made Better, 20 pages.

Guarantee Construction Co., New York, N. Y. Retail Coal Pockets, 32 pages.

Westinghouse Electric and Mfg. Co., East Pittsburg, Pa. Baldwin-Westinghouse Electric Mine Locomotives. 33 pages.

American LaFrance Fire Engine Co., Elmira, N. Y. Fire Protection for Mines, 31 pages.

The Jeffrey Mfg. Co., Columbus, Ohio. Jeffrey "Arcwall" Coal Cutters for "Over Cutting" System of Mining, 10 pages.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Portable Air Compressors, 32 pages. Jackhamer Mounting, Type JM–6, 4 pages.

Boiler Water and Its Troubles

(Continued from Page 528)

present, appreciable amounts of ammonia may be absorbed. Fatty acids are quite soluble and the water may contain considerable quantities of these. The substances resulting from the decaying animal matter are not often present in significant amounts except in the neighborhood of important industrial centers.

Various mineral substances are absorbed by water in quantities depending upon the amount exposed to the action of the water and to the solubility of these substances. One substance which occurs in most soils is limestone or calcium carbonate. This is soluble in pure water to the extent of about 3½ grains per gallon. But in the presence of carbon dioxide, calcium bicarbonate $CaH_2(CO_3)_2$ is formed and is quite soluble. This substance and magnesium bicarbonate, which closely resembles it, constitute "temporary hardness" of water, so called because the compound is decomposed by heat with the formation of calcium carbonate, which is practically insoluble, and is therefore precipitated.

Gypsum, $CaSO_4$, is soluble in water at ordinary temperatures to the extent of about 140 grains per gallon. This mineral is found quite frequently in soils. Silica, SiO_2, is found in all soils and is somewhat absorbed by water, and is one of the constituents of scale. Among the other substances found in small quantities are magnesium sulphate $MgSO_4$; iron carbonate, $FeCO_3$; magnesium chloride, $MgCl_2$; calcium chloride, $CaCl_2$; and sodium chloride, $NaCl$.

Sulphuric acid is sometimes found free in water, especially in mining districts. It results from the oxidation of pyrite, which is commonly found in mining districts and constitutes the principal amount of sulphur in coal. In the presence of air and moisture, changes occur which may be represented by the following formula, though it is probable the reaction is more complicated:

$$FeS_2 + 7O + H_2O = FeSO_4 + H_2SO_4$$

The $FeSO_4$ is gradually changed to ferric hydrate, or more probably to a basic ferric sulphate, while the SO_4 is set free. It is thus seen that water from coal mines is almost sure to contain free acids. However, the extent to which these changes have taken place by the time the water leaves the mine is very different in different places. Sometimes, especially in the case of comparatively new mines, the water is not yet acid, and in other cases it is brown with ferric sulphate, and in other cases the iron has been nearly all precipitated. In some places waste acid from industrial plants is emptied into streams.

The quantity of free acid contained in the water depends not only upon its original contents of free acid, but the extent to which this acid has been neutralized by alkalies. Calcium carbonate is dissolved by sulphuric acid with the formation of calcium sulphate. So it may happen that water originally strong in sulphuric acid will contain no free acid

after passing over a bed of limestone, though it will be hard. It is found that streams in mining districts lose their acidity in this way.

Assuming that water contains the various substances which have been mentioned, we will see what happens when it is put into a boiler. As the temperature rises the absorbed gases are given off, and if the water is held for a short time at a temperature of 212° F., nearly all of the absorbed gases will be evolved.

During this period of heating certain chemical changes are accelerated, and certain substances which are ordinarily stable are decomposed, so that effects may be produced which would not be expected from a first glance at the composition of the water. One of these changes which has been known for a long time is the decomposition of calcium bicarbonate, as follows:

$$CaH_2(CO_3)_2 = CaCO_3 + H_2O + CO_2.$$

The calcium carbonate which is nearly insoluble is deposited. Part of it will attach itself to the metal of the boiler and will produce a so-called soft scale. This is one which is easily removed. This scale is porous and interferes less than hard scale with the transfer of heat

Ferric sulphate, $Fe_2(SO_4)_3$, is decomposed as the boiling point is approached, as follows: $Fe_2(SO_4)_3 + 6H_2O = Fe_2(OH)_6 + 3H_2SO_4$. A similar decomposition occurs in the case of aluminum sulphate. In reality the decomposition is probably to a basic sulphate which contains the metal, the OH group, and the SO_4 group. These basic salts are of variable and doubtful composition; it is simpler to make the assumption that the hydrate is formed, and no serious error results from this assumption so far as the present purpose is concerned. Then any water containing iron or aluminum sulphate will yield free acid in the boiler and will produce the same effect as if it had contained free acid.

This sulphuric acid will attack the metal of the boiler and form a ferrous sulphate, $FeSO_4$. If the water in the boiler contains free oxygen, this ferrous sulphate will be changed to ferric sulphate and this ferric sulphate will in turn be decomposed into the ferric hydrate and sulphuric acid. It will thus be seen that the acid will continue to act upon the iron as long as oxygen is supplied to cause the oxidation and precipitation of the iron.

This decomposition of salts is not confined to sulphate. Magnesium chloride, $MgCl_2$, is decomposed and the insoluble magnesium hydrate is formed. This will appear either as sediment or as scale:

$$MgCl_2 + 2H_2O = Mg(OH)_2 + 2HCl$$

The hydrochloric acid thus formed will attack the iron in a manner similar to that of sulphuric acid. It has, however, one important difference, in that it is volatile and will pass into the pipes and cylinders, attacking the metal wherever it is exposed to its action.

Most substances become more soluble when the temperature is increased. One important exception is calcium sulphate which is soluble to the extent of about 140 grains per gallon at ordinary temperatures, but becomes almost insoluble at boiler temperatures and is deposited almost entirely upon the metal of the boiler, forming hard scale. This hardness, due to calcium sulphate and other substances which are not decomposed like calcium and magnesium carbonate, and are therefore not removed by heating to the boiling point at atmospheric pressure, is known as permanent hardness.

Although scale is composed quite commonly of calcium and magnesium compounds, it is not intended to imply that these are the only constituents of scale. Silica is frequently found in water and is a scale forming substance. Aluminum and magnesium compounds are also found.

Rapid evaporation of water will commence when the boiling point is reached and will continue as long as the temperature is maintained. During this period the water itself and the volatile substances contained in it pass off and the non-volatile substances remain, and as the feed-water brings in a fresh supply of

these non-volatile substances, they constantly become more concentrated. For an example, take water containing 25 grains of dissolved substances per gallon. A boiler developing 300 horsepower continually will evaporate approximately 27,000 gallons of water per day. Calculation shows then that 96.42 pounds will accumulate in the boiler per day, and 674.94 pounds per week. This accumulation of substances necessitates the blowing off of boilers, and the frequency of blowing off, of course, increases with the amount of material dissolved in the water.

Suppose that a boiler is operating at 150 pounds pressure and that 500 gallons of water are blown off in 24 hours. The heat lost amounts to 1,295,900 B. T. U. Assuming coal with a heat value of 12,000 B. T. U. per pound, this is equivalent to the loss of 108 pounds of coal, or assuming a boiler efficiency of 70 per cent., it is equivalent to the loss of 154 pounds of coal per day.

The subject of corrosion is one which is now being quite extensively studied and which seems to deserve more discussion than that already given. It is due to various substances among which are oxygen, carbon dioxide, and the vegetable and animal acids already mentioned, and to electrolytic action.

It is probable that the oxygen in the boiler does not directly affect the iron, but rather that it acts after the iron has been dissolved. It is supposed that water is dissociated into *H* and *OH* and that the *OH* unites with the iron to form ferrous hydrate. This is oxidized by the free oxygen into the comparatively insoluble ferric hydrate which passes out of solution. The process of solution of the iron would be automatically stopped if it were not for the action of the oxygen. This removes the iron which has been dissolved and also united with the *H* and permits the process to continue as long as oxygen is supplied. The effect of oxygen is illustrated in the case of a boiler plant which was examined by an engineer. He found that the boilers were quite corroded, and yet

a thorough examination of the feed-water showed that there was nothing in it which could attack the iron. After a careful search it was found that there was a leak in the suction pipe and air was being pumped into the boiler. When this leak was stopped the corrosion ceased.

Carbon dioxide in the water is also corrosive, as it unites with the iron to form ferrous carbonate. This, like ferric sulphate, is oxidized and precipitated as ferric hydrate, while the CO_2 is set free.

$$2FeCO_3 + 3H_2O + O = 2Fe(OH)_3 + 2CO_2$$

It will be seen that the CO_2 is free to attack the iron again. If no oxygen is available, the last reaction cannot take place, and the only product will be carbonate of iron, which will remain as a neutral salt. Many waters contain considerable quantities of carbon dioxide, and commonly oxygen is present. This subject of the action of oxygen and carbon dioxide requires much fuller investigation, as it is only recently that the bad effects of these gases have been recognized.

There is another possible cause of corrosion which should be mentioned, namely, the decomposition in the boiler of the sulphate scale. This sometimes occurs when the scale has accumulated to considerable thickness and its insulating effect has caused the metal to reach a temperature at which the scale next to the iron has been decomposed, with the result that the sulphuric acid has attacked the iron causing corrosion under the scale.

No attempt has been made to make this discussion of boiler troubles exhaustive. In the present state of knowledge of the subject such treatment of it would be impossible. What has been said is only by way of illustration by a few examples.

It is only within the last few years that a realization of the magnitude of the losses due to bad water has been felt and with that realization has come the application of the remedies. A second article to be printed in June will discuss the treatment of boiler water.

Operations in the New River Field

(*Continued from Page 537*)

87. Refuge holes must be made, and the same whitewashed and kept clean on all haulage roads. Have refuge holes at all doors. 25.

88. Have all loose slate taken down on haulage roads. 20.

89. Use a light on the rear of all trips, whether empty or loaded. 10.

90. All motor roads must be bonded as laid; bonding must be tested frequently and kept in repair. 25.

91. Use a drag on the rear of all trips on heavy grades. 15.

92. Allow no person to ride on loaded trips, except the trip rider who must ride on the rear of trip. 10.

93. All main and side entries must be made so as to have 5½ feet clear space on top of the ties. This does not include air-courses where rooms are not to be turned. 20.

94. All outside trolley wire shall be placed 6½ feet above the rail. 10.

STABLES

95. Stables in the mine must be ventilated by fresh air; the air in the stables shall go direct to return. .05.

96. No open lights are to be used in any stable. 10.

97. Running water is to be placed in all stables where practical. .05.

98. Water barrels and casting pails shall be maintained in stables. Barrels must be full of water containing one peck of salt dissolved. .05.

99. Hay shall be kept in fireproof vault near stable entrance. 10.

100. One fire extinguisher is to be kept in each stable at the entrance. .05.

PUMP ROOMS AND SUMPS

101. Pump rooms must be kept clear of refuse and in a tidy condition at all times. .05.

102. A receptacle must be kept for oily waste so it will not get scattered about. .05.

103. Sumps are to be thoroughly cleaned and of sufficient size to hold 24 hours' capacity of water. .05.

104. Wherever a pump is located in the mine, a sump is to be made and not allow the pump to have its suction line along the roadway on a level with the ties. Gathering sumps shall have not less than 100 cubic feet capacity, and at least 4 feet deep. .05.

GENERAL

105. Wiring is to be done according to rules on wiring. Trolley wire is to be protected at switches, crossings, sidings, or at any point where it is necessary for men to cross under the trolley wire. 15.

106. On gathering hauls, the trolley wire must be placed on the chain pillar side of the entry. If necessary to have two trolley poles, they must be provided. 10.

107. Have the traveling road or second opening in good traveling condition and well drained at all times. 15.

108. Have all machinery guarded to prevent accident from same. The necessary bits shall be removed from mining machines before moving to prevent accident to men and mules. 15.

109. When a place is abandoned, all posts, ties, wire, etc., must be removed at once to a safe and convenient place. 15.

110. Pumps and all machinery must be oiled and properly taken care of; loose bearings or bolts very often cause serious trouble. .05.

111. The mine foreman shall take his dinner into the mine and remain there during the noon hour.

112. Fire bosses must not go home for breakfast, but may eat the same at the top of the shaft after their first examination.

113. In every mine where a fire boss is employed, the mine foreman must carry a safety lamp.

114. None other than authorized employes and those permitted by law shall enter any mine without written permission from the general manager's office.

115. The mine will start dumping at 7:30, and all day men must work nine (9) hours at their working places.

NOTE.—Within 6 months from the date of these rules, all iron, ties, wire, posts, and other material of value, must be removed from the old workings, unless the company inspector has agreed with the superintendent that it is not practical to do so.

The Alabama Safety Association

The Alabama Safety Association has proposed to hold a field day meet in Birmingham during the latter part of May, which will be open to all classes of men engaged in industrial operations in the state. A program will be arranged which will be of interest to all the railroads, steel plants, coal mines, and other industries. The proposed plan is to hold the meet on the 28th and 29th of May. The first day of the meet to be given over to an Institute Meeting, at which papers will be discussed. In the evening a banquet will be set. On the following day a tour of inspection of some of the plants of the district is proposed, after which the state-wide field day meet will be held. In the evening a smoker is to be given at which the prizes for the various events will be awarded.

Delay Fuses

Blasting in shafts and headings by the use of electromagnetic batteries is now successfully accomplished by making use of "delay fuses." These are fuses which require time, the fraction of a second to cause an explosion. By this means, "cutting holes" may be fired first, the "intermediate holes" next, and the "square-up holes" last.

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The Colliery Engineer

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Mines and Minerals

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The Hojo Coal Mine, in Japan—I

An Extensive Mine in Which Occurred an Explosion Second Only in Fatal Results to That at Courrieres

*By S. Meguro**

HOJO colliery, in Japan, was the scene of the most serious coal mine disaster in the history of that country. An explosion occurred there on the 15th of last December which caused the death of 672 men and an immense damage to the mine; so that this ranks second in loss of life among the great disasters of the world's mining history. It deserves the serious and detailed study which has been given it by Mr. Meguro. Because the description of the explosion, the exploration of the mine, and the investigation of the possible cause of the disaster, are so interesting that we cannot greatly condense Mr. Meguro's paper without sacrificing something of its value, it is published in two parts, the second of which, dealing with the investigations into the cause of the explosion, will appear in the July issue.—EDITOR.]

Hojo colliery is located at Hojo village, Tagawa district, Fukuoka prefecture. It is about 34 miles from Moji Port and about 1 mile from Kanada station of the Kiushiu Railway. A branch line has been constructed between this station and the mine for carrying the coal produced and mine supplies. The colliery is the property of the Mitsubishi Limited Partnership, of which Baron Iwasaki is director.

*Chief Engineer of Fukuoka Komusho. Mine Inspection Office of the Department of Agriculture and Commerce.

The area of the property is 1,606 acres. The natural surface features consist partly of rice fields and other cultivated lands, enclosed by hills on the northeast. The Hikosan river flows from south to north through the western portion of the property. To the east, Sannodake mountain towers high among the clouds. Scattered here and there upon the mountain's side are forests of pine trees which add greatly to the beauties of the scene.

Geologically, the formations consist of alternate layers of shale, sandstone, and conglomerate of the Tertiary age. It must be remembered that all the coal fields of Japan belong to the Tertiary formation and that there are no Carboniferous strata here. The shale is rather soft and friable, gray or light brown in color. The sandstone is also friable and light brown or dark brown in color. The conglomerate is hard, generally coarse grained, and developed to a considerable thickness. As this Tagawa coal field lies close to the volcanic rock of the Sannodake mountain, the coal has been considerably metamorphosed. The strike of the strata is north 12 degrees east and the dip averages 12 degrees toward the east.

The strata which bear the coal seams were subjected to pressure in an east and west direction and are extensively interrupted by faults running in a north and south direction and nearly parallel with each other.

Coal Seams.—There are three groups of coal seams, upper, middle, and lower. The upper group contains the Kusaishi Three-Foot seam (thickness, 3 feet) and the Wakubuchi Three-Foot seam (thickness 3 feet 6 inches). The middle group consists of the Shiakunashi seam (thickness, 2 feet) and the Nanaheda Three-Foot seam (thickness, 2 feet 6 inches). The lower group consists of a 3-foot seam, the Nanaheda Five-Foot seam (thickness, 5 feet 6 inches), the Eight-Foot seam (thickness, 7 feet 6 inches), the Gosuke seam (thickness, 1 foot 6 inches), the Banshita Five-Foot seam (thickness, 5 feet), and the Tagawa Four-Foot seam (thickness, 3 feet 6 inches). Of these, the workable seams are the Eight-Foot seam and the Tagawa Four-Foot seam; the former is the one chiefly developed while the latter is not yet extensively worked. The analyses of the coals from these two seams are as follows:

	Eight-Foot Seam Per Cent.	Tagawa Four-Foot Seam Per Cent.
Moisture	2.42	2.41
Volatile matter	26.98	39.33
Fixed carbon	67.80	50.19
Ash	5.22	7.74
Sulphur	.37	.33
Specific gravity	1.28	1.27
Heat values, B.T.U.	13.608	13.404

This coal is non-coking.

Fig 1. Map of Hojo Mine 1 inch = 854 + ft.

Mining.—The mine has two shafts 180 feet apart. The hoisting shaft, which is the upcast and is also used for drainage, is 896 feet 7 inches deep and 18 feet in diameter; and the downcast shaft, which is also used for transportation, is 893 feet 7 inches deep and 14 feet 6 inches in diameter. Both shafts are brick lined and provided with steel headframes 75 feet high. The cage used weighs 1.7 tons and carries two cars having a capacity of .6 ton each. The hoisting rope of mild steel has six strands, each consisting of eight 125-millimeter wires and seven 65-millimeter wires, and is 1⅜ inches in diameter. The cages run on four guide ropes, one at each angle. These guide ropes are 1⅛ inches in diameter, made of mild steel with six strands. A tail-rope extends from the bottom of one cage to the bottom of the other and is of the same construction as the guide ropes. The cages are provided with detaching hooks but have no safety catches.

Underground Workings.—From the bottom of the downcast shaft, a passage called the Togo incline extends eastward 810 feet. Parallel to this and 120 feet from it is the Kuroki incline. From the bottom of the upcast shaft, the Oyama incline extends eastward 960 feet. These three roads are the principal roads of the mine and are used for ventilation, drainage, and the transportation of coal.

From the Togo incline, the Nogi level extends 1,200 feet to the northward. At this point, the strike of the coal bed is changed about 90 degrees and the level is turned to the left through about this angle and is known as the New Nogi level. The New Nogi level is 1,110 feet long. From this level, inclines numbered from 8 to 13 extend to the north. The longest of these, the ninth, extends 1,920 feet. From this incline, levels 1 to 18 are turned 120 feet apart. From the third level of the Togo incline a road called the Left Mata incline, 930 feet long, extends to the northeast. From the end of this passage, an incline called

the Second New Mata incline, extends 900 feet to the eastward. Parallel to this incline, and 120 feet from it, is another incline of the same length called the Pipe incline. On the left side of this incline are levels 9 to 15. The thirteenth of these, which is the longest, is 900 feet long. From it are turned inclines 1 to 7. From the eleventh

this, levels 5 to 18 are turned. The longest of these, 12 to 16, reach a distance of 540 feet. These levels are intersected by inclines 18 to 23 inclusive.

From the third level of the Togo incline, an incline called the New Togo incline, extends 360 feet to the northeast. This New Togo incline, on account of change of dip, really

of the fault by two galleries, one of which is called the self-acting plane and the other is called 2½ water-level gallery. From the further end of this self-acting plane, an incline called the Second Mata incline extends 1,450 feet to the southeast. Levels 1 to 5 are turned to the southward from this incline and also the Nogi level and upper levels 1 to

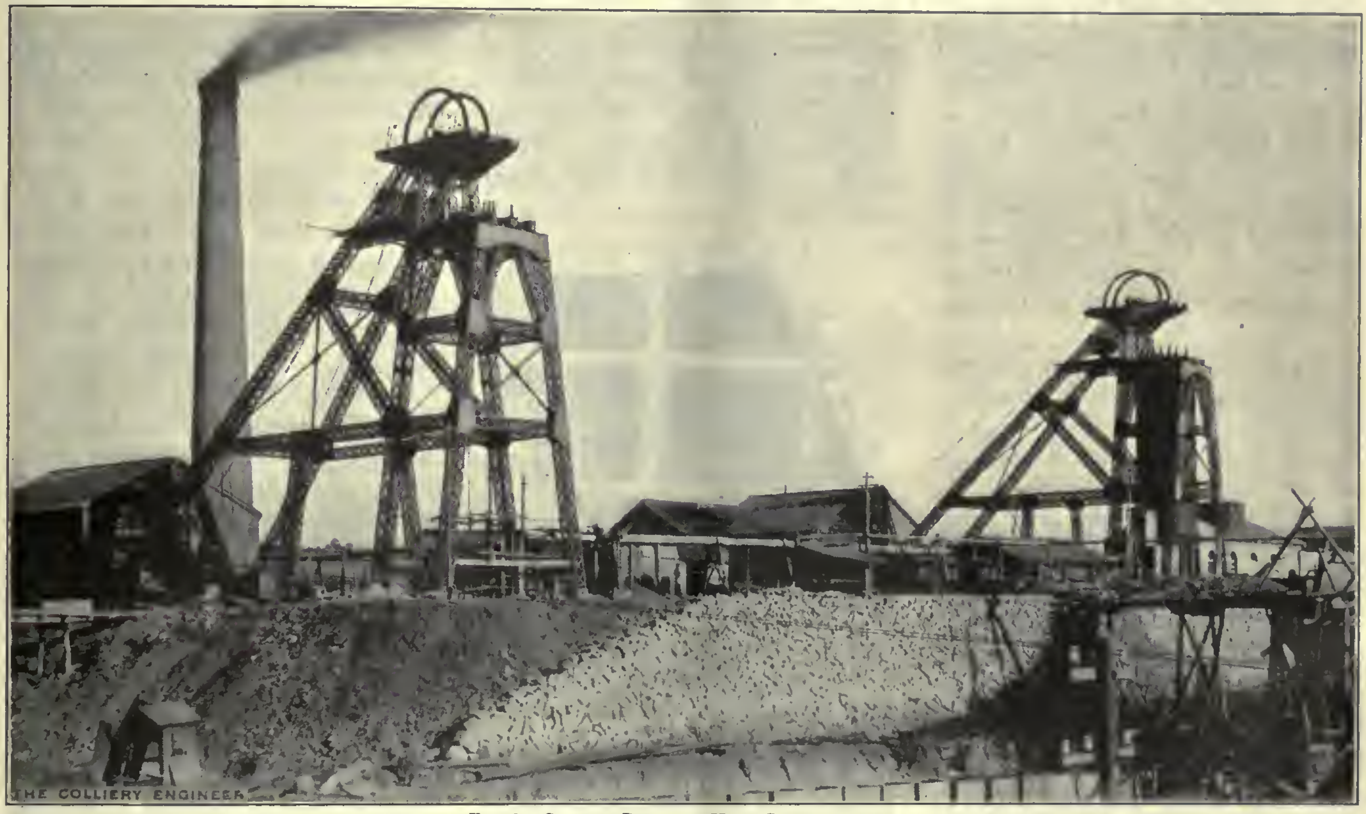

Fig. 2. Surface Plant at Hojo Colliery, Japan

level of the Second New Mata incline a road diagonally inclined extends 1,200 feet to the southeast. Levels 11 to 21 are turned to the south from this incline. Levels 15 to 19 are the longest and reach 870 feet. Intersecting these levels are inclines 1 to 8.

From the New Mata incline, at a distance of 930 feet, a level called the new seventh level has been opened following the strike of the coal seam for a distance of 1,440 feet to the northwest. From the end of this level the fifteenth incline extends 540 feet to the northeast. From this, levels 8 to 18 are turned; 360 feet westward of the eighth level, the Third New Mata incline extends 1,350 feet to the north. From

rises by 36 feet. On this incline are levels 1 to 6 and inclines 1 to 9.

From the Oyama incline, levels 1 to 8 are turned to the right. Nos. 1, 2, and 2½ are the longest and reach a distance of 3,000 feet. From these levels, inclines Nos. 1 and 22 are turned. From near the junction of the first level and 6th incline, an incline called the Right Mata incline extends 1,050 feet to the southeast. Parallel to this are the old Pipe incline and the 8½ incline, the former 840 feet long and the latter 1,140 feet long.

On No. 2½ level, 3,000 feet from the Oyama incline, the coal seam is cut by a great fault which has displaced the seam by 90 feet. The seam is connected on the two sides

3, the first, third, and fourth levels extend for a distance of 1,560 feet. From these levels, inclines 23 to 39 are opened for a distance of 1,150 feet. The thirty-first incline is called the Third Mata incline and is used as a hauling incline, being provided with an electrical hauling engine. From the rise side of the upcast shaft, a gallery is driven from the shaft bottom 750 feet to the west, called the Oyama rise. On the north side of this rise are upper first to sixth levels extending 2,100 feet and crossing and intersecting these are inclines 1 to 20. On the south side of this Oyama incline, inclines 1 to 26 were driven starting from the upper sixth level which is 3,060 feet long.

From the third level of Kuroki incline, the New Kuroki incline extends 2,050 feet to the southeast. Parallel to this and 120 feet south of it another incline, called the New Oyama, extends 1,450 feet. This is used at present as a pipe and cable way. From these inclines are turned levels 3 to 15. From the eighth level of the New Kuroki incline, another incline called the fourth incline is driven 1,780 feet to the southeast. From this are turned levels 12 to 17. From the fifteenth level of the New Kuroki incline, an incline was driven 810 feet to the east. This is called the Second New Kuroki incline and from it levels 16 to 22 are turned. The relations of these openings are clearly shown on the accompanying map of the colliery.

The method of mining is post and stall working. The daily output of coal averages 700 tons, of which 70 tons is shaly coal which is used under the boilers at the colliery. At present, three seams are being worked, the Eight-Foot seam, the Nanaheda seam, and the Four-Foot seam. The most extensively worked is the Eight-Foot seam. When the pillar of the Eight-Foot seam is worked, the roof, which consists of the Nanaheda seam, immediately falls and the Nanaheda coal is taken out. The lower seam of 4 feet is still in the course of preparatory working from the Right Mata incline, right level 2½.

According to the reports for 1914, the number of employes is 1,640, distributed as follows: Miners, 1,025; water workers, 8; miscellaneous, 70; repair men, 537. Besides these, there are 98 porters, 13 carpenters, 43 carpenters' assistants. On the surface there are 266 coal pickers, 24 firemen, 89 mechanics, 32 carpenters, 15 electrical engineers, 131 miscellaneous.

The pillars are made 90 feet square and the levels, 10 feet wide, are placed at 100-foot intervals. When a fault is encountered, it is the custom to commence work in a return direction. As the mine contains many faults, it is very expensive to keep a gallery open for a long time, and this method of entirely working out the district enclosed between two faults is the most economical. There is very little material to be packed in the goaf. The coal is hard and the amount obtained per man is 80 cubic feet. Since the seam on the hither side of the fault is all worked out in a return direction, there is no back road to be kept open. The method of working is illustrated in Fig. 2. The coal from the lower 55 feet of each pillar is carried downward into the next level, while that from the upper 35 feet of each pillar is carried into the upper level. As these distances are small, it is not necessary to carry much of the coal in baskets.

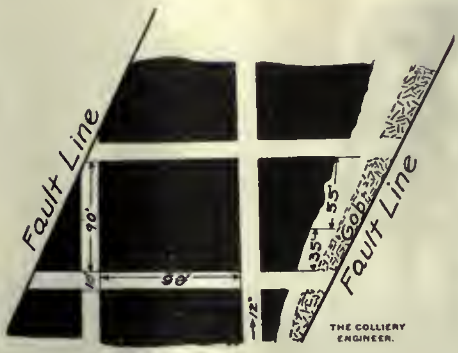

Fig. 3. Method of Working

Transportation.—Most of the coal is carried in cars, so rails are laid as near as possible to the working face. On the levels, the cars are hauled by horses or by men. On the inclines they are hauled by electric haulage engines or by an endless-rope system. Although the frequent occurrence of faults makes the driving of regular inclines and levels impossible, still by laying track in the levels and inclines as much as possible, the transportation of coal in this mine becomes less laborious than in other mines. Thirteen electric haulage engines are used underground, having an aggregate of 322½ horsepower. All of these are of the "gas-proof" type. One 80-horsepower steam engine is used to operate an endless-rope system. There are also five self-acting planes. Thirty-five horses are used underground, and track is laid with 16- to 20-pound rails on an 18-inch gauge. The cars weigh 1,000 pounds and hold 1,500 pounds. The hoisting engine at the upcast shaft has a 14-foot drum, 5 feet long. The cylinders are 24 in. × 56 in. At the downcast shaft there is an 11-foot drum, 8½ feet long. The engine cylinders are 22 in. × 48 in.

Drainage.—At the shaft bottom are two Riedler steam pumps, having a capacity of 160 cubic feet per minute against a head of 1,050 feet. At present 85 cubic feet per minute is pumped. At the first landing are two centrifugal pumps with a capacity of 50 cubic feet per minute against a head of 250 feet, and at the second landing are two centrifugals with a capacity of 30 cubic feet per minute against a head of 300 feet. These pumps handle 67 cubic feet of water, so that the total amount is 152 cubic feet (1,137 gallons) per minute. Besides these pumps, there are 12 electrical pumps underground aggregating 89 horsepower. Four of these are centrifugal pumps and the others three-throw plungers.

Ventilation.—At the upcast shaft, there is a Rateau fan 12.2 feet in diameter, 30 inches wide at the inlet, and 14 inches at the outlet, driven at 180 revolutions per minute by a 120-horsepower engine. This fan produces a water gauge of 3 inches and exhausts 154,000 cubic feet of air per minute.

The fresh air, amounting to 141,000 cubic feet per minute, is divided into four splits, passing respectively through Togo rise, left Nogi level, Togo incline, and Kuroki incline.

Blasting is performed entirely by an officer called "blasting overman" and the work is never left to miners. When a charge is to be fired the overman examines the neighborhood for gas. If the amount of gas is below 1 per cent., dynamite is used, which is fired by a fuse ignited with a joss stick. If gas is present to the amount of 1 to 1½ per cent., an electric blasting machine is used. If gas is found to the amount of 2

per cent., blasting operations are entirely prohibited.

The mine is somewhat gassy, though the ventilation is so good that gas almost never accumulates in noticeable quantities. Safety lamps are used exclusively. Practically all of these are oil lamps, most of which are of the Clanny type. A few electric lamps are used. Every miner is examined before he enters the mine to see whether he carries any matches, tobacco, pipe, tobacco pouch, dynamite, or other dangerous substance. If anything is found in the pockets of the miner or concealed in any way about his person, it is examined, and if it is capable of producing fire, it is removed.

Examination of bodies, after the mine explosion revealed nothing which could produce fire, but an abundance of playing cards, dice, and cash, for gambling purposes.

In order to provide for smoking on the part of the miners and at the same time prevent the danger which would follow the indulgence of the practice in the working places, special smoking rooms were provided in which the men might smoke without endangering the mine.

Conditions of the Explosion and Recovery of the Bodies.—At 9:40 A. M. on Tuesday, December 15, 1914, a great roaring sound was heard by the porters and overseers on the surface who were not far from the shaft mouth. Then the concrete lining of the shaft mouth was blown off and approach to the shaft was impossible. A moment later both shafts emitted with violence a great cloud of black smoke and dust which continued to issue for about 20 minutes. So great was the force of the explosion that the cage which rested at the shaft mouth was blown up to a height of 50 feet, where it struck the girder of the head-frame and fell back 10 feet, resting there in an inclined position. The safety fence surrounding the shaft mouth was entirely blown away. The tail-rope passing from one cage to the other was torn off about half way down the shaft. Because of these injuries, hoisting operations were made utterly impossible until repairs were made.

The casing which covers the mouth of the upcast shaft, constructed of ⅛-inch steel plates with ⅜-inch rivets at 2½-inch pitch, was torn to pieces and blown away. The iron door of the casing, 3 ft. 7 in. × 8 ft. 2 in., built of steel plates riveted to a 2″ × 2″ × ¼″ angle iron frame, was also blown away.

In the Kanada and Hokoku collieries, which are about 1½ to 3 miles away, there was heard a roaring sound like distant thunder and at the same time window glass, zinc roofing, plates, etc. vibrated for a moment. These facts furnish some indication of the great force of the explosion.

The technical administrator at once examined the ventilating fan and found that it was not damaged but that the fan drift which leads the air from the shaft to the fan was fractured at the arch and that the iron casing and iron door were blown off from the mouth of the upcast shaft as previously mentioned. Therefore, he at once closed the mouth of the upcast shaft with planks and sealed it hermetically with clay. Also he closed the fractured fan drift with clay and started the fan.

In a short time one of the cages was repaired and he descended into the downcast, having first lowered an electric lamp and a telephone to the shaft bottom. Though no one spoke through the telephone, it was known from the sound of voices heard that some men were still living.

It was at 3 P. M. that the cage was lowered as quickly as possible and 12 men were rescued who were in the neighborhood of the shaft bottom. Many of these men were severely wounded.

I arrived at the colliery at 7 P. M. and after making the necessary inquiries immediately descended the shaft accompanied by several officers. The descent of the cage was very slow because of several obstructions and about 15 minutes were consumed. The cage could not reach the bottom, but stopped about 18 feet above, because the broken ropes and cables were piled up in the shaft bottom. The water which issued from the breaks in the shaft flowed like a cataract. The electric lamps used to illuminate the shaft bottom were all extinguished by the breaking of the wires. The crying voice for help, the dead bodies lying about, the disemboweled horses under the stones, all these were indeed a pitiable sight that one could hardly bear to look on.

At this time, my object was to find out how to rescue the men as soon as possible. With this in view I went as far as the third level on the Togo incline about 360 feet from the shaft bottom; but, as the afterdamp still filled the colliery, further exploration was considered very dangerous and three of the party returned to the shaft bottom. Some members of the party, not accepting our advice, proceeded a little farther and at once became poisoned by the gas, falling into a comatose state. Then Mr. Kikeda brought back the two men who were overcome to the shaft bottom and commenced artificial respiration, by which means one was resuscitated soon, but the other did not recover until after an hour.

The cage was stopped 18 feet above the shaft bottom, and it was very difficult and tedious work to get the injured men on to the cage, as it was necessary to climb up an unstable ladder. Thirty minutes or more were required to carry one man up to the cage. As this was the case, there was danger that it might be too late to apply medical treatment to the injured or asphyxiated men. Therefore, I called a doctor to the shaft bottom where there were many injured men and had emergency treatment given to them. The doctor, after treating ten men or more was overcome. It then became clear that the fresh air did not circulate regularly in the downcast shaft because of a short circuit through the first and second landings. Therefore these openings and

the pump station at the shaft bottom were sealed with planks. By this means the fresh air was brought into Togo incline.

At this time it was planned to explore first the left Nogi level in which it seemed that many miners still remained alive. With this object, the rescue party went into the left Nogi level at about 10 P. M. on the 15th of December. The men found were all dead. As the bodies were not burned and death was due to suffocation, it seemed that the flame of the explosion had not circulated there.

As the Riedler pump was broken by the explosion, the water had gradually accumulated at the shaft bottom until its depth reached 4 feet 6 inches and it became very inconvenient to pass through, consequently a bridge was built to aid in conveying the dead bodies. To meet the requirements of the case a centrifugal pump of 50 cubic feet capacity was sent in Togo incline at the right first level to drain away this water into the goaf of the Right Mata incline.

It took 3 days to fully explore the Left Nogi level. Fifty or more dead bodies were found there. After the completion of the exploration of this level the fresh air was immediately turned into the Right Mata incline and the search for bodies was commenced. In this part of the mine roof falls and dislodged props were numerous. As a long time would have been required to thoroughly repair the gallery, it was opened only enough to permit passage over the fallen rock, and through such roads the bodies were carried.

After the exploration of the Second and Third Mata inclines, the air was directed into the Left Mata incline, the New Seventh level, the Fifteenth incline, and the Third New Mata incline, and here also the exploration was carried on with the removal of bodies. In the New Seventh level the roof had fallen so extensively that the original form of the gallery could not be seen. In the Fifteenth incline and the Third New Mata incline the same condition of destruction could be seen. The height of the fallen rocks frequently reached 20 feet or more, therefore the searching for bodies and digging them out was very difficult work.

The roof falls on the New Togo incline were not great, hence the carrying of bodies was easy, but the flame of the explosion seems to have been very intense, as the surfaces of props were burned to charcoal. On the Second Mata incline the great roof falls were again encountered so that only one-half the number of miners could be found. As it would require a very long time to remove the fallen rock it was necessary to stop exploratory work and send the air into the New Kuroki incline.

It is evident that the water which had accumulated at the shaft bottom and which had been pumped out into the gob of the Right Mata incline would flow down gradually into the dip side of the mine, and that if this water should reach the Fifteenth level the ventilation of the Fourth incline would be stopped. Because of this anxiety the exploration was hastened. It was found that fresh air was circulating in the Fourth incline, and the work of searching for bodies and removing them was carried on without trouble. In this quarter of the mine roof falls were extremely bad, the height frequently reaching 10 feet or more, and at the lower side of the Tenth level of the Fourth incline the falls of rock were still greater. As the search for bodies in the lower portion of the Second Kuroki incline of the Sixteenth level was prevented by the accumulation of water, the draining of this was hastened. Since the pump could not be brought into this portion of the mine because of the obstruction of fallen roof, it became essential to the work of rescue that the fallen rock be cleaned up as soon as possible. The work of cleaning up the falls, repairing timbering, relaying rails, replacing ventilating doors, repairing air bridges, closing the airways, etc., and the search for bodies, was carried on in every quarter of the mine.

Up to the present (January 10, 1915) the number of dead bodies carried to the surface was 482, the number of men rescued alive 22, and of these two died subsequently, so that only 20 men escaped. The number of dead bodies which remained in the mine at this time under water or fallen rocks, was 183.

Total number of men in mine at time of explosion	687
Rescued alive (recovered)	20
Died after rescue	2
Dead bodies conveyed to the surface	482
Dead bodies still in the mine	183
Victims of the explosion	667
Rescue party, killed by gas	4
Rescue party, killed by falling roof	1
Total lives lost	672

(To be continued)

Coal Production of Pacific Coast States

The production of coal in Washington, which is the only coal producer of any importance on the Pacific Coast, has been considerably reduced during recent years by the great output of petroleum in California and its use as a manufacturing, railroad, and steamer fuel. It is estimated that the consumption of California oil for fuel on the Pacific Coast is equivalent to about 20,000,000 tons of coal, or about six times the output of coal in Washington or, for that matter, in all the Pacific Coast states combined, in 1914, which was, according to E. W. Parker, of the United States Geological Survey, between 20 and 30 per cent. less than it was in 1913, when the production amounted to 3,877,891 short tons. Operators are of the opinion that the steamer consumption of coal was somewhat less in 1914 than in 1913, because of the European war, and that an equal quantity was lost through the smaller consumption by smelters because of the decreased production and low price of copper. Eighty per cent. of the decrease in production, however, was due to decrease in demands from railroads and manufacturers, and in the domestic trade owing to the scarcity of money among householders. A decrease of at least 250,000 tons in the state is estimated in the domestic consumption alone.

Sydney, Cape Breton, Coal Field

Climatic Conditions Necessitating Storage. Large Operations Extending Under the Sea

By J. F. Springer

THERE are in Canada two principal coal fields, one in the extreme east and the other far to the west. Between the New Brunswick and Nova Scotia areas and those of Alberta and British Columbia there is a barren interval 2,000 miles broad. The chief centers of population lie between a northern prolongation of the boundary between Maine and New Hampshire on the east and Michigan on the west. Consequently, any large exploitation of the coal fields necessarily involves big questions of transportation.

The New Brunswick coal measures cover a large area; but production is being actively prosecuted at only a few scattered points. The total output is unimportant and is mostly consumed locally. Similar remarks may be made with respect to the coal seams located on that part of Nova Scotia which is attached to the mainland, except that the output is not negligible. The really important coal field of eastern Canada is located in that part of Nova Scotia known as Cape Breton Island, and indeed in the single county of Cape Breton. The county of Inverness on the western side of the island has coal measures, but they have not as yet become important.

The productive area extends in a fairly broad band along the northern seacoast from Mira Bay on the east to St. Ann Bay toward the west. The coal seams are in part below the ocean floor. Roughly, they are included in a rectangle 35 miles long and 10 or 15 miles broad. How far the seams extend beneath the ocean is not known. So it may be that ultimately this rectangle will be found to be much too narrow. This is the Sydney coal field. The principal towns and harbors are Sydney and Glace Bay.

The total output of the Sydney field is about 5,000,000 long tons. About half of this is used locally or is shipped to near-by districts. But about half is sent to distant destinations. Perhaps 8 per cent. of this comes to the United States for use in the Everett gas works near Boston. The remaining 92 per cent., or something over 2,000,000 tons, is shipped to points on the St. Lawrence River, particularly Quebec and Montreal. These shipments are made principally by special colliers. The distance to Quebec is about 700 miles and that to Montreal about 850. The round trip to the latter point may be made in 6 days, including the time consumed in discharging coal at the destination. These vessels carry cargoes running up to 12,000 tons. The vessels of a non-specialized type carry ordinarily cargoes of a smaller size, say, 7,000 or 8,000 tons.

Dominion No. 1 Colliery, Output 5,100 Tons Daily

All points included in the routes of the coal vessels are further north than the 45-degree parallel of latitude. Part of the route is as far north as the 49-degree parallel. It will be readily understood, then, that the year is divided into a closed and an open season. Coal may be shipped for about 7 months, from May to November. For the remainder of the year water transportation is at a standstill. But this part of the year is precisely the time when coal is in most active demand. It will be easy to see from the foregoing that the mines must store their winter output and the consumers must store a great part of their summer's receipts.

This question of storage has become quite a problem, not so much at the mines, for there the coal does not seem to heat to the combustion point, but at the great piles at the other end. It does not seem to be thoroughly understood just why there should be excessive trouble from spontaneous combustion at Montreal and none at all at Cape

Breton. At the mines, the coal is stored in piles reaching heights of 20 to 30 feet and higher; at Montreal piles half as high give trouble and in a short period. Mr. Edgar Stansfield says in explanation that the difference in experience arises "probably because the coal in Cape Breton is in comparatively large lumps, comes straight from the mine saturated with hydrocarbons, and is stored in winter and, therefore, cold; whereas the coal in Montreal is more broken up and almost like slack, is saturated with air rather than with hydrocarbons, and is stored in summer and, therefore, often hot."

Storage under water is undoubtedly a successful method. This has been shown by the British Admiralty and others. The United States Navy will maintain extensive piles under water at both termini of the Panama Canal. But the water will not freeze at Panama; whereas in Canada it will lock the coal up tight at the very time it is most wanted. It has been suggested in effect to store under water in a cement tank and then draw off the water in the fall after the coal has been thoroughly chilled but before actual freezing takes place.

It is claimed that a thoroughly ventilated pile will not develop spontaneous combustion, and the Canadian Pacific Railway Co. have a large pile near their Angus shops at Montreal where they employ a system of ventilation. A large number of special ventilating pieces distributed all over the pile presumably facilitate the circulation of air through the body of the pile. The cost of arranging ventilation in this way is said to be considerable. Furthermore, there is probably a certain amount of deterioration arising in the case of any coal stored in the air, whether ventilated or not. On the other hand, storage under water or in a drainable cement tank involves ordinarily an appreciable addition to the cost of the fuel because of the interest charges on the capital outlay. The writer ventures to suggest that perhaps the tank would not necessarily have to be of cement. What is needed seems to be only a sufficiently deep basin with an impervious bottom provided with a means of drainage operable at will.

The output of the Sydney coal field is about 40 per cent. of the total for all Canada. The land area involved in the productive coal measures is about 225 square miles. As to the submarine deposits, it is thought that those on land are "probably the segment only of an immense basin, extending toward the coast of Newfoundland." Mr. F. W. Gray adds to this the statement: "From explorations already made, it is probable that the future possibilities of this submarine coal field will be limited rather by the difficulties attendant on the extraction of coal at long distances from high-water mark than by the failure of the coal seams." At no less than five points the coal measures have been involved in vertical folds, the high spots constituting the present land area and the intervening hollows various bays or parts of bays indenting the coast. The same seams of coal reappear in the various deposits; but this matter has not been worked to a finish as yet. Of the coal seams of a productive character, more are represented in the Victoria-Lingan basin extending from Indian Bay to the great indentation known as Sydney Harbor. The various seams here vary from 2 feet 8 inches in thickness to 8 feet. The total depths of all seams is within a vertical half mile. The thicker measures on shore have been so thoroughly worked out during the past half or three-quarters of a century that the thinner seams are now being dealt with and the submarine measures attacked.

The submarine measures promise to be highly productive. Thus, it is pointed out that it is to be expected that the aggregate vertical depth of 39 feet of coal seams, now known to exist in the land shaft of the Hub colliery within a vertical interval of 1,300 feet, is to find its counterpart in the near-by under-sea field. Similarly, the 48 feet of coal in a vertical half mile of the Victoria-Lingan basin is probably existent in pretty much the same distribution in the submarine coal measures adjoining.

The principal coal company in the Sydney field, and in fact in all Canada, is the Dominion Coal Co., Ltd. Its activities are chiefly confined to operations in the Sydney field; but it has other and scattered interests elsewhere in Cape Breton Island and on the mainland portion of Nova Scotia. The remaining concerns engaged in mining in the Nova Scotia district (including Cape Breton) do in the aggregate about 8 per cent. of the business. The Dominion Coal Co. is a chief subsidiary to the Dominion Steel Corporation. A large percentage of its annual production of 5,000,000 tons is consumed by the Dominion Iron and Steel Co., Ltd., in their big works at Sydney, where they have 620 retort coke ovens and a pay roll of 13,000 names.

Another principal mining concern is the Nova Scotia Steel and Coal Co., Ltd. This company has extensive holdings in the areas to the west of Sydney Harbor. It operates five collieries and produces some 800,000 or 900,000 tons annually, a large part of which production goes to feed the furnaces of its own steel works at Sydney Mines, Cape Breton, and at Trenton.

It will be of interest to know something as to the character of the coal being mined in the Sydney field. In the first place, it is all bituminous. Canada is very deficient in anthracite coals. A sample of coal from a mine of the Dominion Coal Co. was tested at McGill University and found to have the following chemical constitution: C, 76.7; H, 5; S, 2.4; N_2, 1.6; O_2, 8.4; ash, 5.9. These are percentages by weight. The thermal content, per pound, was 13,860 B. T. U. Another sample from the same mine had a thermal content of 14,310. The chemical analysis was substantially the same except with respect to carbon and ash, which were 80 and 2.7 per cent., respectively. The mine is in the district east of Sydney Harbor, Dominion No. 7, Hub seam. Another sample, Dominion No. 10,

Unloaoing Nova Scotia Coal at Quebec

Emery seam, had a thermal content of 13,120. All these samples came from the Glace Bay district. To the west of Sydney Harbor is the district known as Sydney Mines, operated by the Nova Scotia Steel and Coal Co., Ltd. A sample from No. 1 colliery was found to have a chemical analysis as follows: *C*, 75.4; *H*, 5.1; *S*, 2.9; *N*, 1.3; *O*, 8.1; ash, 7.2. The thermal value was 13,770. From the same colliery, another sample had a thermal value of 14,490. It will be gathered from these statements that the Sydney coal field contains some very good coal.

Colliery No. 2 of the Dominion Coal Co., Ltd., is perhaps the largest colliery in America. Its capacity for bringing coal to the surface is 6,000 tons per day. Up the one shaft, coal is brought also from No. 9 colliery. There are thus two seams reached, the Phalen and the Harbor. The latter is met at a depth of about 400 feet. The total depth of the shaft is about 800 feet. This same seam is supposed to be represented in all the four principal basins of the Sydney field. In the Sydney Mines basin, between Great Bras d'Or and Sydney Harbor, the seam is known as Sydney Main. In the Lingan-Victoria basin, between Sydney Harbor and Indian Bay, as Victoria; and in Morien basin, to the east of Glace Bay, as Blockhouse. In the Lingan-Victoria basin, the seam lies at a depth of 894 feet and is 7 feet thick. The Phalen seam is also supposed to occur in other districts. In the Glace Bay basin it lies at the depth of 850 feet; in the Victoria-Lingan basin, where it has the name Lingan, the depth is 1,346 feet. These depths must be understood as referring each to a single location. The hoisting equipment is notable as having perhaps no duplicate anywhere. The coal is brought by 2-ton cars to the foot of the shaft. Here they are discharged by rotating tipples into pockets provided with chute extensions. These are, of course, below the level of the tipples. The hoisting buckets or tanks have a capacity of 6 tons each. Their loading is accomplished automatically by the release of catches connected with the system of chutes. This release is effected by the empty bucket. When full, the bucket is automatically hoisted and dumped onto screens at the bank head. A record has been made of 57 hoists per hour. This would seem to indicate a capacity of 342 tons in the same time.

Reference has already been made to the coal of No. 7 colliery on the Hub seam. The reason for the name "Hub" seems to be the fact that the colliery is situated at the center of a series of concentric semicircular seams. It is one of the oldest mines in the Glace Bay district. The shaft is only 130 feet deep. In the next

district to the west, the Victoria-Lingan basin, what is supposed to be the same seam is found at a depth of 523 feet. In the former district, the seam is 9½ feet thick; in the latter, 6 feet. The workings in the Glace Bay colliery are principally seaward. No. 7 colliery is practically a submarine mine.

Dominion No. 7 Colliery, Output 950 Tons Daily

Another submarine mine is No. 1 colliery of the Nova Scotia Steel and Coal Co., Ltd. The workings comprise some 2,400 acres off the entrance to Sydney Harbor. They belong to the district known as Sydney Mines, to the west of the harbor, and represent, so far, the most considerable effort at recovery of undersea coal in the Cape Breton region. The face of the deeps is now perhaps 1¾ miles seaward from the shore line. Other areas belonging to this same company lie twice this distance out. It seems, though, that the Dominion Coal Co. owns an intervening strip. This, the former concern has now released; so that ultimately it is expected to develop a very extensive group of submarine workings

There are in the Cape Breton region quite a number of separate submarine mines. In fact, the future development must largely be beneath the sea. It is expected that coal may ultimately be mined as far out as 5 or 6 miles from the shore. Apparently, in certain parts of the field, there is little or no limit known as to the distance out at which coal may be found The probabilities seem to indicate that it will not be the coal seams that will fail. Submarine workings have been carried on on the other side of the island in Inverness County. Two of these have been flooded, the Mabou mine in 1909, the Port Hood mine in 1911. In the case of the former mine, the thickness of the roof lying over the working and beneath the water was, at the point where the water came in, but 110 feet thick; but in the case of the second mine it was supposed that the roof was as much as 942 feet thick where the water entered. When the water first began to flood the mine, it entered at the estimated rate of 3,000 gallons per minute. The break occurred at a point where pillars were being withdrawn. As between the two sides of the island, it would appear that the conditions controlling in the Sydney field are much more favorable. Mr. F. W. Gray says in this connection: "On the western side of the Inverness coal field the strata are much fractured, and the coal seams dip very steeply. In the Sydney coal field the seams have only slight dips, and the strata overlying and intervening between the coal seams consist of strong sandstones and impermeable marls and shales. Faults are rare, and the sea bottom is usually rock, without great thickness of sand or sand pockets."

What is worthy of especial note is the fact that in the Sydney district more than one seam of coal is being worked in the same submarine area. An example is found in the workings of the Dominion Coal Co. in the Glace Bay basin. Here the Hub, Harbor, and Phalen seams are all being worked simultaneously. No. 1 colliery with a 160-foot shaft is working on the Phalen seam. Part of the operations are on the land side, part on the side of the sea. The submarine face is 3,000 feet or more from the shore line. No. 6 colliery is operating workings that are almost entirely submarine. No. 7 colliery is, as already stated, working the Hub seam by a 130-foot shaft. Its activities are largely beneath the water.

The submarine operations have to be carried on in conformity with special provisions of the Canadian mining laws. As conditions could not be foreseen except in a general way, the Commissioner of Mines is given large discretionary powers. There must be a minimum thickness of 180 feet of solid material above any coal being worked. Passageways to coal deposits may be opened where the cover has a minimum thickness of 100 feet. The panel system of mining must be pursued where the overhead cover is less than 500 feet thick. A single panel must not have a floor area of more than one-half a square mile. The coal barriers surrounding must have a minimum thickness of 90 feet. Where the cover has a thickness in excess of 500 feet, the approval of the Commissioner is the only special restrictive requirement. The cover at the shore line in the case of No. 6 colliery is not more than about 375 feet; but as the seam passes out to sea, this thickness rapidly becomes greater and greater.

The Dominion Coal Co., Ltd., stores part of its winter coal in a

bank having a capacity of some 400,000 tons. While the period of storage is not long, say 4 or 5 months on the average, nevertheless the coal suffers an appreciable amount of disintegration which necessitates resizing. There is a rescreening plant which is served by small cars which bring the coal from the bank up an incline to the screens. The loading of these cars is done by steam shovels working on movable tracks. At the rescreening plant, the sized coal is loaded onto railway cars and transported to the docks. There are five sizes, domestic (2½ inches and over), screened (¾ inch and over), run-of-mine, nut (between ¾ inch and 1½ inch), slack (everything below ¾ inch).

Smoke Accident at the Moller Pits of the Gladbeck Colliery

This accident, by which two men lost their lives, is chiefly remarkable as one in which the breathing apparatus failed.

A fire broke out in the engine house and several of the men sent to determine its extent had inhaled the fumes before putting on the apparatus. After undergoing great bodily exertion in traveling and in part creeping through the passages, one after another of them had fits of giddiness and two of them, unable to proceed, succumbed to the fumes, after the oxygen in their apparatus had become exhausted; while a third, whose helmet glass got broken, narrowly escaped. The lesson from the accident is considered to be that the inhalation of the fumes of combustion, even when greatly diluted must not be taken too lightly, and that its effects, though not noticed at the moment, will show themselves under exertion afterwards; further, that artificial breathing apparatus should be used only by men who thoroughly understand its use, one of the men having failed to avail himself of his full supply of oxygen in the case in point.—*A. R. L. in Trans. I. M. E.*

Keeping Power Plant Accounts

Supplies Account—The Day Book and the Account Book. Monthly Reports—Checking Up Results—Guarding Expenditures

*By Charles J. Mason**

ONE of the most important duties in a power plant is the keeping of accounts relative to the material and supplies used. Of course it will be understood that the magnitude of such an undertaking depends upon the size and kind of the plant, and the extent to which the engineer in charge is concerned with the handling of such accounts.

In some places the engineer has little or nothing to do with the accounts. Supplies are ordered from the office of the concern and the bills for them are sent direct to the owners or agents, the engineer's interest consisting merely in receiving and consuming the material purchased. Again, the engineers of some plants order their own supplies by making a regular requisition on the purchasing department of the office of their concerns, while the bills may be sent direct to the office for payment. They will require the indorsement of the engineer as an acknowledgment of the receipt of the goods as ordered. It frequently happens that the engineer is also a superintendent or manager, who not only receives supplies but receives and audits the bills.

In the larger plants, an accountant is engaged to attend to that part of the business, under the general direction of the chief engineer, whose many duties do not permit him to devote the amount of time to them that such accounts require. But he should be able, by thoroughly understanding the system in vogue, to see almost at a glance just how the accounts of his plant stand at any time.

In order that the purpose for which accounts are kept may be fulfilled, system, method, and accuracy must be strictly observed, for without them a hopeless tangle may result which will probably require the services of an expert to unravel. Not only are the accounts to be kept of all supplies purchased, consumed, or otherwise disposed of, but a periodical statement, or report, as it is called, is required by the owner, so that he may see just how his business stands. As a general rule these reports are made monthly, each one contributing toward the continuity of the whole, which of course necessitates accuracy from beginning to end. As before implied, accuracy in turn depends upon system and method of work.

Methods employed in keeping accounts may be good, bad, or indifferent, according as to how well either fulfills the purpose for which it exists. As a matter of fact, nearly every engineer who keeps accounts at all has his own method of so doing, and the accuracy of the results will depend upon how efficient the particular method is. The following simple system is worthy of consideration: It is necessary to decide into how many divisions, or individual accounts, the general accounting is to be carried, and for what period of time before balancing up.

The number of individual accounts will depend largely upon the size of the plant and the variety and quantity of material which is used. As a matter of convenience, as will be explained further on, many articles can be grouped together under one heading, and charged out against the various units in the plant, for maintenance or repairs, thus closing that particular account, which of course means that no balance will be carried into the succeeding period of time. With regard to the period of time to allow the accounts to run before balancing, it may be said, the individual taste of

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the engineer, or the requirements of his employer, are the main points concerning a decision. The longer they are allowed to run, the more difficult will they be to handle, although in some cases the reverse is true, because of the more frequent summing up and closing, which of course means more labor. All things considered, it is fair to assume that the engineers' accounts should be closed or balanced monthly in order that a multiplicity of items and prices may be avoided.

The daily quantities of material consumed, or transferred to any other department of the business in general, should be entered in the day book, or log as it is often called, Fig. 1. All well-regulated plants should keep a day book. Besides the entry of material consumed, etc., a record of all that transpires during the day (subdivided into watches in some places) is kept for future reference, and also to serve as a check upon the accuracy of the monthly accounting. At the expiration of every week a summing up should be made, and the results entered in another book, in their respective places and regular order. This second book is the account book, a sample page of which is shown in Fig. 2. At the end of the month each account in this book is balanced or closed, and, if required, a report may be made—compiled from the various account pages of the book.

When a requisition is made out for supplies, etc., a copy of such should be kept on file, and when the goods are received each item should checked off; there will also be an entry in the day book of the receipt of such goods. At the end of each week the receipts, together with the prices and amounts, are entered in the account book, while the bills for such goods (or duplicates for such) should be placed on file, so each of the operations will check and verify the other, thus reducing the liability of mistakes, to a minimum, if not entirely. Of course, the report (where such is required) should be compiled after the checking off has been done. It can thus be seen by the thinking reader that such a system can be referred to at any time, and the exact standing of the accounts ascertained. The material received, with date, price, and amount; the material which has not yet been received up to a certain period, and therefore carried over into the next period of time; the consumption of material in quantity and cost, operation or repairs; the balance on hand with its cash value.

Fig. 1. Specimen Page of Engineer's Day or Log Book

Monday, July 6, 1914

A. M.	Watch No. 1	From 12 to 8
Number of boilers in service		2
Number of engines in service		2
Steam pressure (gauge), pounds		100
Coal consumed, pounds		6,000
Ashes, pounds		1,800
Water consumed (cubic feet), meter readings:		
At beginning of watch	040,625	
At close of watch	041,230	
Total, cubic feet	605	
Cylinder oil, gallons		1
Engine oil, gallons		1½

Repairs:—(Here follows a list of repairs that may have been made.)

Overhauling:—(Here follows a list of work overhauled during the watch.)

Materials consumed:—(Here follows a list of materials, etc., such as waste, oils other than those before noted, fittings, etc.)

Received:—7:45 A. M. one (1) barrel cylinder oil and one (1) barrel engine oil, from oil company.

Remarks:—(Here follows an entry of incidents, or changes that may have been made, shutting down engines, or cutting out boiler, banking fires, etc.)

Fig. 2. Specimen Page of an Account Book

1914 Coal Account 1914

Date	July	Cr.	Dr.
July 1	On hand, 100 tons, at $2 per ton		$200
July 6	Consumed, 30 tons, at $2 per ton	$ 60	
July 13	Consumed, 35 tons, at $2 per ton	70	
July 20	Consumed, 32 tons, at $2 per ton	64	
July 22	Received, 150 tons, at $2 per ton		300
July 27	Consumed, 34 tons, at $2 per ton	68	
July 31	Consumed, 22 tons, at $2 per ton	44	
	Totals		
	Received, 250 tons, at $2 per ton		500
	Consumed, 153 tons, at $2 per ton	306	
	Balance, 97 tons, at $2 per ton	194	
	August		
Aug. 1	On hand, 97 tons, at $2		$194

(Continued weekly as above)

The cylinder, engine, and other oils and material here follow, the same form as above being used.

Now, with regard to the items in the general accounts, let us take the following as an illustration, to explain the working of the methods before referred to. They may be divided thus:

Coal.

Cylinder oil.

Engine oil (and other oils, if constantly used).

Waste.

Miscellaneous.

Under the heading of miscellaneous may be placed any materials, tools, appliances, etc., which it is not desired to carry in stock (as far as the books are concerned), but which are charged out for the purpose obtained, immediately, even though such articles, may not have been actually all used as charged. For instance, a number of globe valves are required, and purchased; they are received and entered in due form. Perhaps only one-half of the number obtained is used during the month in which the purchase was made and the account balanced; but instead of carrying the balance over into a new month, assume that all have been used for the purpose procured, and thus close that particular account to make room and time for others of a similar nature, which will appear in the future. Of course, it should be understood that when large quantities of such supplies are ordered and kept on hand, it would not do to dispose of them in the manner just referred to, but a regular continuous account must be made, as of coal, oils, etc.

Fig. 3. Miscellaneous Account

Date	July, 1914	Cr.	Dr.
	Miscellaneous		
July 1	Received from——Co. per bill, one (1) bbl. lime at		$ 1.25
	Engines		
July 8	Received from——Co. per bill, 25 lb. engine rod packing at $1		25.00
	Miscellaneous		
July 10	Received from——Oil Co. per bill, 5 gal. of lard oil at 60c.		3.00
	Boilers		
July 12	Received from——Supply Co. per bill, 50 lb. red lead at 6c.		3.00
July 18	Received from——Co. per bill, four 4-in. boiler tubes at $5		20.00
	Miscellaneous		
	Received from——Ice Co. per bill, 800 lb. ice at 25c. per 100		2.00
	Total		$54.25
	Consumed for boilers	$23.00	
	Consumed for engines, pumps	25.00	
	Consumed for sundries	6.25	$54.25
	No balance		

Supplies, or material other than those tabulated, may form part of the accounting system, as for instance, the consumption of water and gas. The forms here given and the system explained, may be modified to suit individual conditions, the idea being to give the reader a principle to work upon, and fictitious figures to illustrate such principle; even figures and round numbers are given in the illustrations for the sake of simplicity.

Fig. 4. Specimen Monthly Report—Engineers' Department

Maintenance and Stock Reports for July, 1914 (Compiled from the account book)

Maintenance:		
Coal, 153 tons, at $2 per ton..		$306.00
Cylinder oil, 30 gal., at 50c. per gal..................		15.00
Engine oil, 40 gal., at 40c. per gal.....................		16.00
Waste, 20 lb., at 5c. per lb.....		1.00
Miscellaneous:		
Consumed for boilers..........		23.00
Consumed for engines and pumps....................		25.00
Consumed for sundries........		6.25
Total..................		$392.25
Stock:		
Coal on hand July 1, 100 tons, at $2....................	$200.00	
Coal received July 22, 150 tons, at $2....................	300.00	$500.00
Coal consumed, 153 tons, at $2		306.00
Coal balance, 97 tons, at $2..		194.00
Cylinder oil on hand July 1, etc. (Same form as coal item. Then follows the other items in their regular order.)		
Miscellaneous:		
Received from——Co.........	$ 1.25	
Received from——Co.........	25.00	
Received from——Oil Co......	3.00	
Received from——Supply Co..	3.00	
Received from——Co.........	20.00	
Received from——Ice Co......	2.00	
	$ 54.25	
Consumed for boilers...........	$ 23.00	
Consumed for engines and pumps	25.00	
Consumed for sundries..........	6.25	$ 54.25
No balance..................		

G. B. Wilson,
Chief Engineer

Now to recapitulate; in the system which we are considering, two books only are necessary for the purpose of keeping the accounts, the Day Book and the Account Book. Everything of importance concerning the plant is entered in the Day Book. At the end of the week a summing up is made, and the results are entered in their respective places in the Account Book. On the first day of each month the Account Book is made up and balanced for the preceding month. From the Account Book a monthly report or statement can be made if such is required. Each of the books referred to should be numbered, so that when they are filled they can be filed away and conveniently found again if reference to them is required. Thus, commencing with Volume 1 they may be continued on indefinitely.

The original, duplicate, or triplicate invoices of goods received should also be placed on file, so that they may be referred to when wanted. Filing in monthly batches is probably as good a method as any, to agree with the monthly divisions in the account book and also the monthly report.

In the miscellaneous account, it is unnecessary to state items and dates, as far as this report is concerned, because these appear on the face of the bill, and are transferred to the account book as shown.

This system of accounting will be found easy to compile and adopt, and it will not require any special skill to operate and maintain.

Change in Character of Mining Communities*

According to the census of 1890, less than 10 per cent. of the mining population in Illinois were immigrants from the states of southeastern Europe.

During the decade 1890 to 1900 there was a change in the racial composition of the mine workers in Illinois due to the development of two additional sources of labor supply: (1) An influx of mine workers from other coal fields of the United States; (2) the arrival of immigrants from southern and eastern Europe.

The migration from the other fields in this country was made up principally of the English, Irish, Scotch, Welsh, and Germans, who left the mines of Pennsylvania and other eastern mining states because of labor disputes and the pressure of races of more recent immigration who were entering the industry in those states.

The European races which at the time were securing employment in the mines of the Middle West were north and south Italians, Lithuanians, Poles, Russians, French, and French Belgians, and a few Magyars.

After the year 1900, the movement of immigrant races of southern and eastern Europe into the Middle West steadily continued, and was especially marked during the period 1902 to 1907, on account of the extraordinary development and the opening of new mining districts. During this period a movement of the races of older immigration out of the mines of the Middle West to other mining localities, especially those of Kansas and Oklahoma, under the pressure of the recent arrivals, was also noticeable. In 1910 it was estimated that slightly more than one-half of the total number of employes in the coal mines of Ohio, Indiana, and Illinois were of foreign birth and that almost three-fourths of those foreign born belonged to races of southern and eastern Europe.

The situation at the present, therefore, as regards the racial classification of mining employes, is in strong contrast to that prior to 1900, and it is evident that since that year there has been a constant and increasing influx of races from southern and eastern Europe into the mines of Illinois.

An element of danger to those working in the mines is the fact that many of the recent immigrants do not speak or understand English with any degree of fluency and almost none are able to read or write the language. Because of these facts it is probable that the instructions of those in authority are frequently misunderstood. A mine manager, for example, tells an immigrant miner, in English of course, that his roof needs propping. The miner seems to understand, but does not, and in consequence a fall of top may result in injury to the miner. Printed signs used to indicate the presence of gas or other peril are for the above mentioned reasons unintelligible to many of the foreigners.

*Illinois Miners' and Mechanics' Institutes, Bulletin No. 3. English for Foreigners.

Efficiency in Coal Mining

A Method of Obtaining the Same Labor Efficiency in a Large Mine as in the Small One

By George S. Brackett, E. M.*

EFFICIENCY in the operating equipment, efficiency in the labor costs, efficiency in the use of supplies, are the three divisions under which all efficiency methods may be classed. The first two of these are directly dependent on each other. Efficient results from labor could not be realized without an efficient equipment, although the labor itself may be far beyond criticism considering the methods at hand for accomplishing the work. Take for illustration the transporting of coal from a country coal bank with a wheelbarrow; the results are crude when the amount of coal handled is considered, but the man behind the barrow may be a most commendable workman. More frequently we find a coal mine with equipment beyond criticism and the most inefficient labor. If the same energy and ability which the man manifested with the wheelbarrow were directed and manifolded among all day employes in the well-equipped mine, the results would leave nothing to be desired. The two are distinctly separate, although they must be combined to produce the necessary result.

Rarely are mines operated with any glaring defect in the equipment. For instance, a certain number of mine cars practically fixes the output and any attempt to place more miners than this equipment will accommodate will only result automatically in the miners leaving; or the lost time of the drivers waiting for empties will be noticed and the error corrected. All deficiencies in equipment produce such positive results and are so evident that they are not very frequent, if the desired capacity of the mine is as it stands.

*Flemington, W. Va.

The question of increasing the production is another matter and not considered here. This article treats only of mines which are maintaining their desired capacity, and efficiency methods in this mine as it stands. Another question, too, is whether this capacity is the proper and economical one for the mine in operation, or whether the sales office, executive, and interest, charges are in proportion to this output. Only the operation of the mine as it stands and the management on the ground are considered.

With the assumption that the output is satisfactory, the question of equipment efficiency is not a large one, except in so far as it is or is not handled by the mine labor economically. No management will overlook evident unnecessary labor due to poorly planned tracks for any length of time, nor will they adopt expensive methods of handling water when cheaper are well known and easily obtainable. Automatic trap doors, roller bearing cars, and steel room track are known to every management, and whether they are adopted or not is a case of the operator's opinion as to their ultimate economy. Whether he is right or wrong he has every means of considering the matter, and little more information can be supplied on the subject. Should there be too much lost time on the haul roads, due to conflicting trips, the faults are so manifest that it must be assumed that every competent operator has long since examined these questions and that all coal mines, as a whole, have sufficient equipment. One question along this line, and directly connected with the efficiency of labor, is the existence of surplus or duplicate equipment. There should be sufficient at every coal mine to meet most emergencies. These duplicates should always be in repair and ready for use. This is more essentially a part of the discussion on efficiency of labor and is a means of economy to be discussed later. Idle equipment has no efficiency, except in so far as it replaces a breakdown and permits repairs to be made economically.

Efficiency of labor is entirely another proposition. The tendency of all labor is to deteriorate in the actual amount accomplished if remuneration is made by the time consumed. This is the most common waste in the operation of coal mines. The reverse is the case if payment is made by the actual amount performed. Although little attention is generally paid to this fact, the difference is very evident if men are watched. If the same energy and efficiency that is manifested in the loading of coal by the ton or car could be directed to that class of work commonly called day work, a high grade of economy in our operation would be reached. The inefficiency in this day work is well known and often mentioned, but the discussion is generally ended by mutual agreement as being an item beyond the control of the bosses and a waste that must be carried as an unavoidable operating expense.

The judgment of the boss as to the amount of work accomplished by day workers as he occasionally passes the place of work is the only guarantee of their productiveness, and his judgment may or may not be good. It must be remembered that excuses may be made by the laborers *ad infinitum* as to why more was not accomplished, and the foreman's ability to sift the wheat from the

chaff of excuses consumes his time and more of the laborer's time, and the benefit of the doubt always goes to the day man. In many cases the foreman will decide to watch the work for a few more days in order to be sure that the man or men are not doing the quantity that should be done; he will do this if he is a careful and just foreman, and that is the class of foreman most desired. Another consideration is the fact that there may be some difficulty in getting a man to replace the inefficient man promptly, as employes who have done and will do again any disagreeable piece of work when requested are not very plentiful; and frequently waste in the labor line is overlooked on account of some quality possessed by the laborer. In the foreman's judgment it is policy to retain some employes even though he knows he is not receiving regularly a fair return for the day's wages. Where the quantity of work is left to any one man's judgment, the tendency is always to shirk wherever there is a chance, and the loss or waste is accumulative and never regained. The operator may be perfectly cognizant of this loss but recognizes it as unavoidable.

One of the common causes of labor troubles is the inequality of the wages paid; some men are paid more for the actual work performed than others. Laboring men will ever try to equalize this themselves by using their own judgment of what constitutes a fair day's work and rating the amount by comparison with some other workman on the plant. To be more explicit, if a track gang notices a slate gang "loafing" they will "take it easy" themselves. For why should they work when others do not? The pay is the same, and it is no more than fair that both should take the same ease. Naturally the coal miners, working on piece work, must necessarily produce to get their pay; and for them to see the day men wasting and stealing time without depreciating their wages is a source of dissatisfaction. This frequently leads to miners applying for a day job. In fact, several times in my experience I have had miners ask for a day job, frankly stating that they had been loading coal steadily for several years and would "like to rest up a little." This was taken as additional evidence of conditions already known to exist, but no feasible method was at hand to avoid it. The foreman was doing the best he could to keep the employes busy, but it was beyond his control, as he could not be with them all the time and his greater attention was occupied in the hauling and movement of the coal, and no one was permitted to work when the mine was idle.

Even assuming that the day men are actually conscientious workers, is their work so laid out for them as to be capable of efficient performance? The employes, outside of those directly connected with the movement and haulage of coal, have more or less varied duties. They are called everywhere for emergency work, taken from one duty to perform another of more importance, then back again to work at or to complete their original occupation. There is waste of time walking between duties, passing the tool house to change tools, eat a bite, fix their lamps, wait for the motor or driver trip; their interest is not to get there as quickly as possible but to find legitimate excuses why they are not there. The latter end of the day almost invariably comes with one job completed and not time enough to transfer tools and start another.

Inefficiency and waste is more flagrant in the matter of day labor than in any other. Its elimination is one of the very difficult problems and one of the most important in coal mining. The loss is less in the small mines, where the foreman has more chance to supervise all the work, than in large mines. There is less labor lost in traveling from one job to another in the smaller mines. Assistant foremen, driver bosses, slate bosses, etc., are usually employed at the larger mines to oversee the work and help the foreman eliminate waste labor, but they are usually paid by the day and their interest is to consume the maximum amount of time. If they are employed on monthly time there is great danger of paying more for bosses than is reaped in results. It is not an economy to put on a $60 stock clerk to save a $30 waste in supplies. Again the assistant foreman's wages are usually based on the number of men under his charge; and if he can increase the number of men in his gang, persuade the foreman as to their necessity, or impress upon him their importance, it is his personal interest to do so. These methods do not lead naturally to efficiency.

A successful mine management must inspire the efforts and energy of all employes to the interest of the employer. Their methods must be open to inspection as to the equitable distribution of earnings, it must be as free as possible from men who draw pay for doing nothing, free from jealousies, contention, and disputes. Each employe must feel that he is on the same basis as everybody else, that there is some reward for competent service, and that there are no favorites. These are all-important items and without them there is rarely ever the cooperation of all employes and the corresponding efficiency.

The problem is a difficult one, and its solution was attempted about a year ago in a West Virginia mine. The idea was to arrange the organization of a large mine so as to approach the conditions more frequently existing in the smaller mines. Bear in mind that an examination into costs of production will almost invariably show that the small mines, less than 400 tons daily, are the ones that are producing the cheap coal. The average capacity of all the mines in Pennsylvania and West Virginia is approximately 400 tons daily, many exceed this and many are less, but that is the average mine. By the law of averages that is the economic capacity. Even looking into the question more particularly, the most economical mines are less than that,

because the number of employes is small and more efficiently supervised with less labor waste.

The mine at which the trial was made was divided into sections employing 20 to 30 miners each. Each section had an independent motor side track or two, but never two sections to the same side track. Each section was given to an assistant foreman or safety inspector or section man, call him what you may. He had complete charge of his small section and to him belonged the credit of its management. He delivered the loaded mine cars onto his motor side track and there his work ended. He was employed with this understanding; however, his duties as walking boss were to occupy only part of his time, and the balance was to be devoted to all the necessary work that was needed in his section. The size of the sections was first discussed by answer to the following question by practical miners: "How many miners could one man look after, visit, and direct the workings according to law, lay all the track, turns, and switches, clean all the small falls of roof, watch and clean the ditches, supervise and direct his few drivers; and be foreman, trackman, timberman, etc., combined; how many miners and what production could he do all this for?" Practical difficulties in the way of location of side tracks and the mine lay-out prevented this minimum limit being reached and it was found impractical to make the sections this small. Incidentally it is interesting to note that about 15 to 20 miners, or about 150 tons daily would keep one man busy as Jack of all trades; but his work would be efficiently accomplished with no lost motion or waste time. The larger section of 20 to 30 miners was adopted and the section man given the authority to find himself an occasional helper.

This eliminated all the regular assistant bosses, track bosses, driver bosses, local pumpers, etc. The section man had his interest at heart, as to him returned the credit of the costs and condition of his section. It was his own responsibility, and in it he took a natural pride. He is intimately acquainted with the weak places in all his track, the location of all his tools and supplies, and they are always close at hand and easily reached. Time lost by laborers traveling across the mine is eliminated; and what is more important the inherent tendency to kill time and neglect work is avoided. The section man's entire interest is to have his "mine" operate smoothly and economically. He is a busy man, he helps the miners with their timbering, helps them with their falls and other difficulties, he works with them for their own benefit. He is acquainted with every bit of dead work which the miners perform in his section and allows them pay accordingly. Should some emergency work develop he enlists into service those miners who are interfered with, and the trouble is soon rectified. Under the old system a messenger would have to travel over the mine hunting for the day men; they would have to travel to the seat of the delay, via the tool house, and the removing of the trouble, as a whole, is cumbersome, inefficient, and expensive. Furthermore, he does not appear to the working man as a needless company extravagance for which they must pay with their labors, as a man with a fat job, nothing to do and plenty of pay, an object of mixed emotions of jealousy and contempt. He is a man picked from their own ranks, who works with them, helps them, and sees that they have their fair share of empty mine cars and just treatment. He is always at hand and easily found for direction and advice. He has time to examine into all claims, discuss ways, means, justice, and injustice with the miners and employes under him, to the effect that a better understanding between employer and employe is reached. A company cannot expect fairness and equity from their employes unless such are practiced by the management, and they are educated, impressed, and convinced of the company's policy and desires along this line.

This mine is practically an aggregation of small mines, in each of which there is the closest possible approach to the conditions existing in the general run of small mines. There is always more of a feeling of fellowship and cooperation existing in the "one-horse" mines than there is in the large mines of large corporations; and that feeling among the employes of the smaller mines, together with the closer supervision possible by the foreman, is what makes their labor costs less per ton. These conditions are closely approached in this unit system of management. There is established, between the workmen and the office of supervision, that communication which invariably leads to the correction of certain inequalities, injustices, and partialities, before the complaint reaches the explosive stage.

Due to the reduction in the number of day employes following the starting of this system, frequently the section man is short a man to perform certain necessary work. He does the only available thing to do, hires for a short time some miner to perform these duties. The section man may work with him, or he is in a position to be there considerable of the time to see that the work is well done, and without waste of labor. Frequently this class of work, such as laying a turn, cleaning a fall, or setting some heading timbers, is contracted at a price based on the foreman's and section man's experience, and the miner is free to perform the work at odd times without conflicting in the least with the loading of his coal.

The advantage is this: Instead of depending on the regular day laborers traveling backwards and forwards performing duty after duty, each small item has to be considered separately and brought to the attention of the section boss, and its cost separately and distinctly shown on the daily time sheet. When it is necessary for the foreman or section man to note these little items and hire each separately done, the same spirit of competition enters that is

manifest when one endeavors to purchase a suit of clothes and get the best possible for the least money. Contrast this with the former method of sending across the mine for some day men who are at the foreman's beck and call, and whose workday is a series of such interruptions. Did you ever attempt to estimate just what percentage of their time these men actually are able to give to the performance of their work, even assuming their willingness and desire to do all they can?

Following right on the heels of the institution of this unit system was the elimination of all regular day employes whose services were not directly connected with, and necessary to, the movement and handling of the coal. The labor or overhead costs of all pay rolls may be divided into three heads: supervision and monthly expenses; the actual movement of the coal from the working face to the railroad car and all the employes necessary to this movement; and lastly, that labor which may be dispensed with temporarily without interrupting this movement, which includes trackmen, slate men, timber men, brattice men, and laborers. The regular employes under this last head may be entirely dispensed with. Their work must be done but it can be more cheaply handled by some other employes. Much may be profitably left until the mine is idle for a day, as very few mines work regularly 6 days per week. Most work, other than hauling coal, may be done more economically when the mine is idle, at a time when the foreman and assistants are not devoting their entire time, as they should, to the economic hauling and dumping of the coal. This is their most important duty while the mine is operating and to it they should give their entire attention.

It is a common fallacy among operators that all the day force at a mine should be "cut off" when the mine is idle in order to economize. This is not economy, it is extravagance. When the mine is running coal, the foreman is swamped with day men to whom he cannot give the proper attention and supervision without neglecting more important duties. When the mine is idle he is not permitted to do this class of work economically. The result is evident. This work is expensively and improperly done, and that class of men who are employed by the day and not directly connected with the hauling of coal have learned that it is almost as easy to get their day's pay for doing little as it is for doing much. The personal interest of the employes who are regularly employed as miners or drivers is entirely different; the extra work which some of them get on idle days will call for more if it is properly done. With the other class of day employes it is the poorly performed work which keeps them busy and is evidence that they are necessary. If they can half fix a piece of track today they are assured of another shift on the same job at some later time.

Another general influence is that of fairness among the miners. They are called upon to keep the mine in repair, and the better it is in repair the more assurance they have of an uninterrupted day's work when the mine is running. They feel that they, themselves, are doing all that must be done around the mine except hauling and dumping the coal. They are getting paid for the time actually consumed in the work, and the money is not being thrown away on a crowd of worthless day men for which they must ultimately pay with their labor of producing the coal. This approaches socialistic doctrine—the man who produces should receive closer the actual value of the product than he does—and if all the work around a coal mine, laying track, cleaning falls, etc., is actually done by the miner and he gets paid therefor, he cannot complain that the profits to which he is justly entitled are wasted on loafing day men and idle bosses. At least the elimination of this claim is approached. The writer is not advancing these claims with a view of defending them, but only because the feeling does exist and is cause of dissatisfaction and discontent. There is no management which can economically operate a plant when the employes are determined to make it expensive; there are too many against a few. It pays, if it is possible at all, to enlist the cooperation of the employes; and with this it is hard to fail.

The same unanswerable argument applies to that force of men whose duty it is to maintain the equipment. The health and life of their jobs depend on the work ahead which they must do. Breakdowns must be repaired promptly in order to lessen the delay caused thereby, and there must be a force of men at hand to handle most emergencies promptly; and the tendency is always to encourage breakdowns. The boss of any repair department, a monthly man, is the only one who personally desires everything to be in perfect repair and condition. If there were sufficient duplicate equipment in the shape of mining machines, portable pumps, motors, spare armatures, etc., to meet most emergencies by replacing the broken machinery, there would be less need for a force of repair men. The proper attention could then be given the broken piece without the frequent "patching" and temporary work and corresponding inefficiency. The work would be done at an opportune time, under favorable conditions, at a less aggregate cost and with fewer day men.

The mine foreman's duties are evident; through him are established the government of all the sections, the general haulage and dumping of the coal, the inspection and direction of all the workings, and the proportioning of the empty mine cars to the several sections. His duties are in no way lessened, but his attention may be more carefully directed to the details of each section without worry as to the operations in another part of the mine. His duties follow more those of a general inspector. He is more of a critic on the existing conditions than one who must hurriedly create those conditions.

Accidents in coal mines are mostly due to carelessness, ignorance, or inability on the part of the miner. The section man is required to visit every working place twice daily with a view of discovering and preventing dangerous and careless practices among the employes, and in this he has been the cause of eliminating many accidents, of enforcing strict timbering regulations, and preventing carelessness in the handling of explosives.

The efficiency in the use of material and supplies can only be brought about by careful watching. Waste is principally due to the lack of supervision over the men who use the material. The practice of carelessness is contagious and the tendency to waste material increases naturally unless restrained. The small mine, or the unit system in a large mine, gives the necessary check to this loss.

The only arguments ever advanced against this system are that the mine cannot be kept in proper operating condition if only idle days are depended upon to perform the necessary work, and that the foreman will not be able to get miners to do the work. Some mining difficulties may be such that some day laborers are necessary, but the closer the system is approached, the more economically will the mine be operated. Some miners object to doing day work, but not all. In neither of these objections have we found much difficulty. The system was not started in a day, and much time passed before it was working successfully, and in the start we had some little trouble along the lines mentioned. This only substantiates the claim that it is impossible to operate a mine economically without the cooperation of the employes. The trial was made, opposition was met, and the system was started a section at a time. Gradually the miners began to render the proper assistance grudgingly, slowly they began to expect the extra work, and finally to seek it. We adopted the system of "making up the turn" to miners who left their working places for other duties. The difficulties disappeared, the general conditions of the mine became more satisfactory, and all the work was done more thoroughly and substantially. Mining troubles diminished, and at the present time we feel little need for any day employes except those used in the actual movement of the coal. There is a satisfaction in knowing that everything at the mine is done with the supervision of one of the bosses and in the most economical way. The mine cost sheet is the strongest testimonial as to the advantage and economy of the system.

[The mine at which this method was developed has a capacity of 800 tons daily. The underground force consists of a foreman, four section men, one and sometimes two track men on the motor road, the necessary drivers, and the miners. In the smallest section the section man does his own driving. The plan has been in operation 11 months. The roof is unusually treacherous. There were 12 accidents in the 6 months preceding the institution of the section system, one of them fatal. In the 10 months following there were three accidents.—Editor.]

Stove and Chestnut Coal in Greatest Demand

Stove and chestnut sizes of anthracite are in the greatest demand and make over 40 per cent. of the cording to the United States Geological total shipments from the mines, acical Survey. They are essentially domestic sizes, and the relatively large proportion they make of the shipments serves as an index to the conditions governing the anthracite trade. Egg coal finds its way principally to the furnaces of residences, and pea coal is used in the same way to some extent, though it is also used for kitchen ranges and some of it goes with the buckwheat, and smaller sizes, for use as steam coal. The same sizes come directly into competition with bituminous coal and are often used mixed with bituminous coal for generating steam.

Causes of Accidents in W. Va. Mines

Mr. Earl A. Henry, Chief of the Department of Mines, of West Virginia, says: "When shooting from the solid is allowed in a mine, without a special permit from the district mine inspector, there is a violation of the law on the part of the manager on down to the man who places the shot, and the unlawful and dangerous practice is too common in this state."

Mr. Henry also expresses the view that all the safety devices ever invented will not prevent accidents unless the elements of danger are removed from the path of the ignorant and inexperienced class of workmen. "It is impossible to watch them all, and the only way to throw protection around them is to remove the danger as far as possible. When an overcharged shot is fired by a man who does not realize just what he is doing, and a dust explosion is the result, the fact that the dust was allowed to accumulate without sufficient sprinkling was an element of danger left in his path. An experienced miner will avoid dangers that the inexperienced one will apparently recklessly seek, when in reality his lack of education of proper mining precautions is the cause. He will not heed danger signals, and especially in gaseous mines he is placing many lives in danger, in addition to his own.

"The coal mines of West Virginia are as well equipped with safety devices as any mines in the world, and if the expenditure of money would prevent accidents there would never be a fatality in the coal mines of the state, for the operating companies are anxious to have them reduced to a minimum, and in addition to all necessary expenditures along this line are encouraging every move for the better education of their employes for their own protection. But the time is ripe for strict attention by mine officials to the small details that cause accidents through the hands of inexperienced men, and as far as possible keep danger out of their path."

The Oklahoma Smokeless Coals

The Panama Coals, Found in the Northern Part of Le Flore County, Some of Which Are Now Being Developed

By Edward F. Hackett

THE coal areas in the northern part of LeFlore County, Okla., are divided by two anticlines, geologically known as the Backbone anticline and the Milton anticline. The Backbone anticline enters the field from the east from the Arkansas-Oklahoma state line, bearing nearly due west to within a short distance of the town of Bokoshe. This anticline derives its name from a low range of hills of the same name. The outcrop of the Panama coal occurs in both sides of this anticline. The Milton anticline derives its name from town of Milton located near its center. This anticline enters the field from the Arkansas River valley on the north about the center of the field and bears southwest to the town of McCurtain, in Haskell County. The west end of this anticline is occupied by a low range of hills, locally known as Pine Hills, and to the Indians as "Teoch Hale," meaning Pine Hills. The outcrop of the Panama coal occurs in both sides of this anticline as in the Backbone.

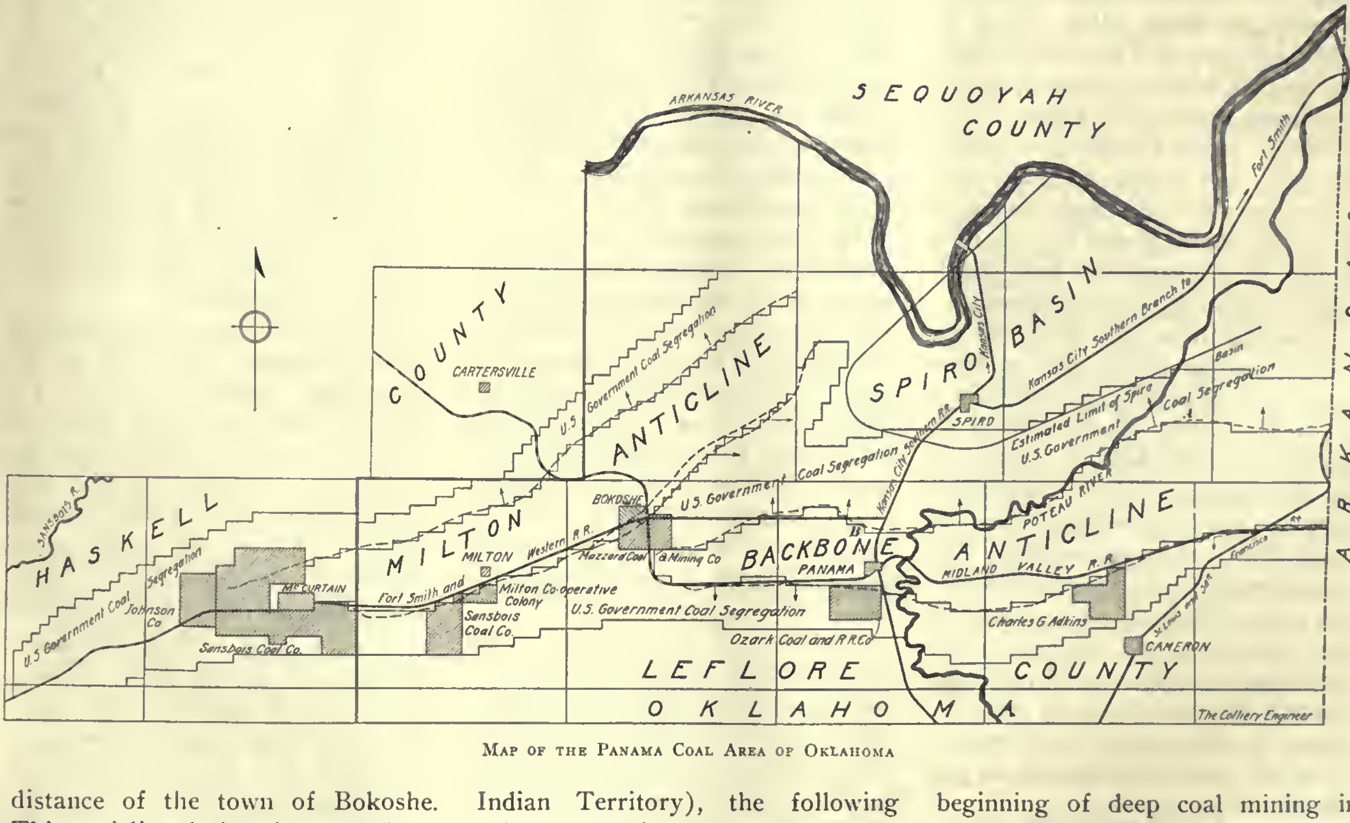
In the segregation of the coal lands of the Choctaw Nation (Old Indian Territory), the following rules governed:

First. The coal should be of a quality and hardness to create a demand for its use for commercial purposes.

Second. It should be thick enough to be worked successfully.

Third. Its structure or position and depth in the earth should assure profitable mining.

At the time this segregation was made and applying to this field, deep mining was not considered profitable, and until the last year or so has not been undertaken in the state. However, the Rock Island Mining Co. has recently completed a shaft a little over 800 feet deep in the Alderson basin. This is probably the deepest shaft in the southwestern coal fields, and marks the beginning of deep coal mining in Oklahoma; and it can only be a matter of time until deep mining will be carried on extensively throughout the state, as the Government has ceased to grant leases (except to those who had openings prior to July, 1913, and then only when shown that it is for the extension of such openings) upon an 8 cents per ton run-of-mine base. New regulations are to the effect that the coal must be shot only with permissible



MAP OF THE PANAMA COAL AREA OF OKLAHOMA

powder, or shots must be fired from the outside with electric shot firing devices where black powder is used. Thus it follows, in view of the royalty bases and regulations which may be enforced from time to time in the future, that the fee or private leased lands will present a much more attractive proposition to the investor. Much of the coal area of LeFlore County lies without the segregated limits, hence the statement as to deep mining.

Referring to the accompanying map, on the north side of the Backbone anticline at (*A*), coal was first mined in the year 1881 by the Poteau Coal Co. under the superintendency of Mr. W. O. Hartshorn. This mine supplied the surrounding country for many miles. Much of this coal went to Fort Smith, Ark., by way of wagons overland, and a tram was constructed about 1 mile in length to the Poteau River where the coal was loaded in barges and stored to await the high stages of the river, when it was sent to Fort Smith, the Poteau River being navigable only at high-water stages.

The coal here dips about 10 degrees northwestward and is from 3½ to 4 feet in thickness showing a 1″ to 2″ parting of shale about 18 inches from the bottom. From 15 to 20 men were worked at this mine, and it was successfully operated until 1894. This is probably the oldest operation in the Panama district. No steam power was used in this operation, the hoisting plant consisting of a winch and mule, the mine being ventilated by furnace. There is one other small wagon mine on the north outcrop of the Backbone anticline, at (*B*) on deeded land and consisting of about 4 or 5 acres.

The limited operations on this outcrop are not due to any fault in the quality of the coal, but probably to the inaccessible condition of the outcrop for railway transportation, and the feasibility of reaching the same coals at other points in the district.

Following out the north outcrop to the Mazzard Coal and Mining Co.'s lease where it cuts in on the southeast corner making a short turn and comes back on the south side of the Backbone anticline, no operations have been carried on until we reach the Ozark Coal and Railroad Co.'s lease of 960 acres near Panama. Two slopes have been opened on it; the first on the east side of the lease, about 1898, went under the Panama lake and was operated for several years, but insufficient pillars were left, and cave-ins resulted in the flooding of the mine and its abandonment. Farther west a second slope was opened and operated, but it has been closed down for several years and is at present filled with water. The coal dips on this lease at about 15 degrees to the south, and there is from 3½ to 4 feet of clean coal, analysis of which by United States Geological Survey is as follows: Moisture, .24; volatile matter, 15.13; fixed carbon, 80; ash. 4.63; sulphur, 1.22; phosphorus, .140.

The next operation, on the old Charles G. Adkins lease, was operated by the Williams Coal Co. for some time, and is locally known as the Williams mine. In the earlier stages of its development one of the entries was driven under the James Fork of the Poteau River and rooms were worked under it. One of these caved during high water, causing the mine to flood. It was shown that only about 25 feet of cover was left in this room.

This lease is now known as the Cameron Coal and Mercantile Co.'s mine and is operated by a new company. The writer in company with Mr. Rule made a survey of the entry mentioned something over a year ago to obtain data for sealing it off with a concrete arch dam. To his surprise trees, some of which were 10 to 14 inches in diameter, which had come in with the water were encountered several hundred feet from the break. Much improvement work has been carried out by the new operating company and it is understood that the property is now in good shape. This slope dips at about 15 to 20 degrees, but changes to about 10 degrees about 400 feet in. The coal at present shows about 4 feet in thickness and will probably vary but little from the Panama analysis.

Of the two outcrops of the Backbone anticline the southern crop dips practically south throughout, and is somewhat heavier in dip at the surface, varying from 15 to 25 degrees, while the north outcrop dips from north to slightly northwestward and the dip at the surface varies from 5 to 15 degrees.

Starting at the north end of the Milton anticline, on the southeast outcrop, it is apparent that some mistake has been made in the fixing of the segregated boundaries, as the outcrop is at places as much as ½ mile without the segregated limits. Several small mines have opened on this land. The coal up to near Bokoshe dips from east to slightly southeast at from 20 to 35 degrees at the surface, and is from 4 to 5 feet in thickness; in some places it shows a shale band of about 3 inches near the center, while in others the band disappears all together.

Mining was begun on the Mazzard lease at Bokoshe about 1902 by the Henderson Smokeless Coal Co. This lease has three slopes on it and is pretty well worked out on the outcrop. As will be seen the two anticlines come to within a short distance of each other at this point, which probably accounts for the two faults which run northeast and southeast across the west half of this lease. The dip is lighter here, varying from 10 to 12 degrees. The thickness of the coal varies, showing on the north side of north fault and east side of lease to be: Coal, 2 feet 6 inches; dirt, 6 inches; coal, 3 feet 2 inches; and on south side of south fault it is from 2 feet 6 inches to 4 feet. While the coal on this property is of good quality these mines have been in the hands of some four or five operating companies up to date.

The next operation is at Milton, the location of the Milton Cooperative Colony. The coal here is about 7 feet thick with a 3-inch to 6-inch

parting near the center. This colony has made a success of the operation up to date and is adding to its equipment as funds will permit.

About 3 miles west, the outcrop leaves LeFlore County, and at McCurtain, Haskell County, are the operations of the Sansbois Coal Co., which has been in the hands of a receiver since the disaster of 1912, the greatest ever occurring in the Panama district, and no mining has been done there since. This property was sold in December, 1914, and is now under the management of Mr. B. J. Jordan, and it is stated that electrical equipment is being installed and that operations are soon to start with machine mining. No operations have been made on the northwest outcrop of the Milton anticline.

The Spiro basin, lying between the V formed by the Backbone and Milton anticlines, is probably the shallowest basin in the county. The estimated limits are shown on the accompanying map and it is estimated by the writer, from reasonably accurate data, that the coal in this basin in the vicinity of the town of Spiro lies at a depth between 700 and 800 feet, while to the west it should not exceed 1,100 feet, and to the northeast not more than 700 feet. The coal in this basin will average 5 feet in thickness and has excellent railway facilities now at hand.

The basin for the south outcrop of the Backbone anticline is probably the deepest and lies to the south of the town of Cameron. The town of Cartersville, Haskell County, is near the edge of the basin for the north outcrop of the Milton anticline and we will call it the Cartersville basin. It is estimated by the writer that the coal here lies at a depth of approximately 1,200 to 1,400 feet. However, it is believed by the writer that the coal here is still dipping to the northwest at a very low angle, and is believed to come to the surface again near the east and west line between Muskogee and McIntosh counties, formerly Creek Nation, about 35 miles distant, where coal is known to exist but has never been followed out by the writer.

Of the Panama coals, it can be said that with the exception of the smokeless coals of Sebastian County, Ark., they have no equal as a steam coal west of the Mississippi River, and they will compare favorably with the famous Pocahontas coal of West Virginia.

All mining in this district is on the room-and-pillar system, and roof conditions are good. All coal is paid for on the run-of-mine basis; the usual grades are fancy lump, modified lump, slack, and run-of-mine. No clay veins or horsebacks are encountered. A few local faults are encountered at places near the outcrop, but are not general; probably the largest is at McCurtain in Haskell County. Open lights are used exclusively in mining, very little gas being found and none where ventilation is up to the requirements of the law. Very little attention has been paid to the engineering in this field and with the exception of the semiannual surveys for the extension of the maps required by law, very little is done, rooms and entries being driven without sights, which has resulted in a recovery of only about 60 per cent. of the coal in place.

Canadian Coal Production, 1914

According to the Department of Mines of Canada, the total production of marketable coal for the year 1914 was 13,594,984 short tons. This is a decrease of 9.4 per cent. in comparison with 1913. The production is distributed as follows:

Nova Scotia	7,338,790
British Columbia	2,238,339
Alberta	3,667,816
Saskatchewan	358,192
New Brunswick	104,055
Yukon	13,443

The imports for the year total 14,721,057 tons, of which 52.8 per cent. were bituminous lump and run of mine, 17.1 per cent. bituminous slack, 30.1 per cent. anthracite. Of the consumption of coal in Canada during 1914, about 45.4 per cent. was from Canadian mines and 54.6 per cent. imported. At the end of the year there were 797 coke ovens in operation and 2,297 idle.

Big Business and the Public

Mr. George Otis Smith, Director of the United States Geological Survey, recently said some things about business and its relation to the people which are worth the attention of coal producers. The occasion was the annual joint meeting of the honor societies Phi Beta Kappa and Sigma Xi, at the University of Illinois. This country has been supplied with cheap coal for years, and naturally the public is suspicious whenever the price is raised. It might be a good thing if the account books of some of the coal producers were opened to the public. Mr. Smith said:

"A working minority of American citizens have come to realize that unregulated private monopoly and citizenship are antagonistic terms. And, now that popular clamor is giving place to sober second thought, the other side of the monopoly question is receiving the consideration it deserves; there is a widespread recognition of the common interdependence of big business and the general public On the one side, the people are realizing that they are and have been in reality silent partners in big business, and now that there has come the promise of some regulation that will in large part prevent monopolistic centralization, the people are interested in getting their share of the returns which can come only with operation at a profit. On the other hand, the managers of the large corporations, who are really the trustees of the investing public, are beginning to see that a certain financial security goes with public confidence. The public cannot be left out of the reckoning, and that well-remembered attitude toward the public so tersely expressed 30 years ago by a pioneer in railroad affairs does not pay dividends today."

Electric Shot Firing in Kansas

Method by Which Shots are Fired in Order From Outside the Mine

By Clark B. Carpenter*

THE methods of mining and of shooting used in southeast Kansas resulted in the injury or death of many shot firers. This has been recognized for a long time and many precautions have been adopted. However, the only sure means of preventing injury while the present methods of mining are employed seems to be the absence of all persons from the mine while shots are being fired. This can be accomplished by the use of an electric firing device operated from outside the mine.

The adoption of the method now used is the result of experiments carried on by the Hamilton Coal and Mercantile Co., of Weir City, Kans. The apparatus used† has been slightly modified and now gives entire satisfaction.

Shooting off the solid is practically universal in southeast Kansas, although it is prohibited by the state law. The miner drills the shot hole, prepares his cartridge, and loads the shot. The shot firer lights the fuse leading to the cartridge. The method, in a slightly different form, is followed in other states, but perhaps with somewhat different results. During the interval from 1902 to 1913, 66 shot firers were killed in the coal mines of southeast Kansas. Ten shot firers were killed during the winter of 1911–1912 alone, and if the number killed since that time were added to the list it would be found to be much increased. There are several mines which have succeeded in gaining bad reputations as places where from six to twelve shot firers have been killed since the mine was opened, and that within a period of about 8 years. Defective and short fuses, pockets of gas at the working face, and the flying coal from the blown-out shots are some of the dangers which confront the shot firer, but windy shots and mine explosions, which occur occasionally, are even more dangerous. These either kill instantly, or fatally burn the victim, or failing in this, the shot firer is left to succumb to the effects of afterdamp.

The practice of firing the shots under the old system is as follows: After the miners have completed their work for the day, have loaded their shots, and have left the mine the shot firer enters the mine. His sole duty consists in lighting the fuses of the shots which the miners have prepared. The natural tendency is for him to fire the shots as quickly as possible, so that he may complete his work and leave the mine. That this is not the best practice has been thoroughly proven. This practice results in stirring up dust with the first shot and at the same time increasing the temperature of the room. As black powder is used, some CO is formed. The heating of the coal by the powder also results in setting free CH_4 and H. In some cases an explosive atmosphere results. The second shot now explodes, and if all is well there may be no explosion, but suppose that the second shot is a windy shot; that is, it simply shoots out a long tongue of flame, which will ignite any gas liberated by the first shot, and in addition some dust. The explosions so commonly met with in this district are the result of conditions of this kind. A miner is allowed to have 25 pounds of powder in the mine with him, the powder being delivered at his switch by the company, and in addition much dynamite is used illegally in shooting the coal The maximum size of cartridge allowed is 40 inches long and 2½ inches in diameter. Stemming is generally dirt from horsebacks, but it is quite probable that coal dust is also used. That too much powder is used is easily shown by stating that only 12 tons of coal are produced per keg (25 pounds) of powder. In one instance a weigh boss who also had charge of the powder, stated that as much as 300 pounds of dynamite per day was used in the mine at which he worked. The result of such conditions has been to cause the death of many shot firers and to produce too much slack coal.

Shot firers are paid at the rate of $3.34 per day in mines where the danger is not too great a hazard, but in mines which have been the scene of two or three explosions the price demanded may reach as much as $10 to $15 per shift.

The first installation of an electrical shot firing device in this field was at Hamilton mine No. 8, near Arma, Kans. It has also been installed in a mine of the McCormick Coal Co. The system is that of the Schietzel Company and depends upon the action of a so-called spark box for its success. The system has been thoroughly tried out at this mine and has proven successful.

In detail, the operation of the plant at the Hamilton mine is as follows: There are two leads of No. 10 B. & S. copper wire extending into the mine and one common wire or return. One lead wire goes to the east side and the other to west side. The common wire splits at the bottom into two wires, one to the east and the other to the west side. The lead

*Lawrence, Kans.

†Electric Shot Firing, by Lucius L. Wittich, Mines and Minerals, Vol. 33, p. 213 (December, 1912).

wires and the common wire are conducted through an iron conduit down the shaft and are connected to a three-pole switch located about 30 feet from the shaft bottom. Another 6-foot, flexible, gap, switch is located some 120 feet further in the mine. These two switches are to serve as protection from lightning, as well as to prevent the premature firing of shots during the day while the miners are in the mine. A copper ground wire which extends through the entire mine serves as a protection from accumulated static charges.

From this gap switch the wires extend to the east and west sides of the mine. The wires are carried on insulators for a part of the distance, but for a large part of the way they are allowed to rest on the floor, with pieces of slate to protect them from the cars, and to keep them from coming loose. This means of carrying the wires has been found to work very satisfactorily and in addition it is not expensive. The ground wire is generally carried under the head of one of the rails, and is connected to each of the spark boxes by a switch beneath the box, Fig. 1.

The spark box is the controlling factor in this system. It is a mechanical device which controls the passage of the firing current and insures that the shots connected to the box nearest the shaft, on either side of the mine, shall be fired first, and that each box shall operate in turn.

This consists essentially of a spark box solenoid *A*, which raises and drops the plunger *F*, depending on whether the current is or is not passing through it; the trigger *G*; the lead wires *H* into the box, *D*, out of the box to the shooting circuit, and *I* to the next box; the common wire *E*; the conducting lever *B*; and the connecting plates *C* and *J*.

In shooting position the arrangement of the parts is as shown by the accompanying drawing. The current enters through the lead wire *H*, flows through the part *B*, through *J* and out through *D*. A shunt is run from *D* to the solenoid and back to the common wire *E*; *B* is held against *J* by a spring not shown in the drawing.

When shooting, the current is turned on, the solenoid is excited and pulls up the plunger *F*, allowing the trigger *G* to fly out, pulling *B* around into a position such that when the circuit is broken, the base of the plunger in falling will hit *B* and press it down against *C*, thus

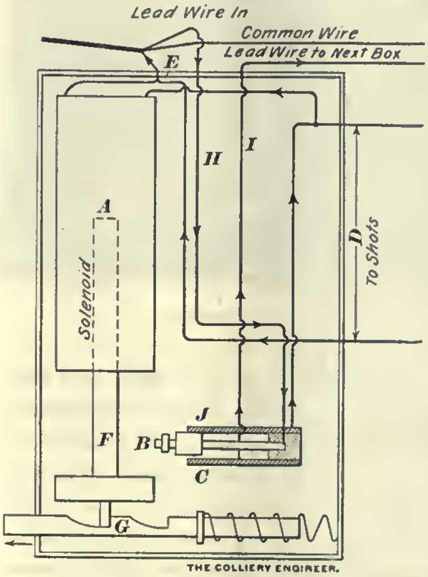


Fig. 1. Spark Box

making the connection to the next box. The solenoid, being connected to the wires of the shooting circuit, is not again excited when the circuit is again closed. The path of the current in the new position of things is *H* to *B* to *C* and out through *I*. The trigger *G* projects outside the box after firing and must be pushed back to its original position before the box can be operated again. This protects the shot firer from a premature shot.

The spark boxes are located along the main east and west entries. One box supplies each front and back entry on either side of the main entry.

The lead wire and the common wire are covered by the same insulation so that the insulation must be cut in order to connect the room wires.

When a room is turned, the miner is given 50 feet of No. 10 insulated iron wire, and an iron conduit carries the wires under the track. This amount of wire is enough to allow him to turn his room and to put in a switch. He is then given 180 feet of new wire, which is connected and is left hanging on supports at the neck of the room, and is uncoiled as needed. When the room is finished, the wire is pulled, and the last 20 or 30 feet is discarded, because the insulation has been shot away. The wire is then wound up and is kept to be used in another room. Very little trouble is encountered in the rooms, except in those cases where the miner changes the wires after the shot firer has put them in place within the room. Fuses of the Red Spitter type are used. The miner loads and connects his own shots. Not more than 2 per cent. of the shots fail.

The shots are fired in the evening after all the men have been checked out of the mine. It is the duty of the shot firer to fire the shots as well as to see that there are no men in the mine, and also that the wiring, spark boxes, and other apparatus are in good order. Before firing the shots he must go through the mine and connect the shot wires to the spark boxes, and at the same time throw out the ground switch beneath each box. He then comes to the shaft, throwing in the 6-foot, flexible, gap, switch, and the three-pole switch, and comes to the surface, where he starts the dynamo, tests the circuit, and fires the shots.

The shots are tested by passing a current from a single dry cell through the circuit supplied by each spark box, before the shots supplied by that box are fired. If the test proves satisfactory the shots are fired. The shots are fired alternately on the east and the west sides of the mine.

After completing the firing the shot firer goes immediately into the mine, pulling the three-pole switch and the 6-foot, flexible, gap, switch, and then he goes to each spark box, and disconnects the firing wires and throws in the ground wire switch. This completes his duty unless he notices any falls of rock or, in extreme cases, fire, and these he should report when he reaches the top.

Fig. 1. Showing Distortion of Big Bed at National Stripping

The common ground wire through the mine was made necessary by the fact that a good ground could not be obtained in the mine. When the apparatus was first installed there were two or three premature explosions, the cause of which was hard to explain, but which was finally attributed to the accumulation of static charges on the spark boxes and the lead wires. Thereupon the ground wire, which is an uninsulated copper wire, trolley wire size, was installed. The boxes are connected to this ground wire by a switch beneath the boxes. The wire is grounded at the top of the shaft. It has proved absolutely satisfactory and there have been no further premature explosions.

Current of 20 to 30 amperes at 175 volts is used. It is probable that not more than 50 to 75 volts is necessary to produce sufficient pressure to overcome the resistance of the firing circuit. .4 ampere is sufficient to explode a fuse, while .9 ampere is sufficient to work a box.

At the present time the system is giving entire satisfaction. It has reduced the price of mining the coal by 1 cent per ton over the cost under the old system, because of the saving in wages paid to shot firers; it has eliminated the danger to the shot firers; and in addition has produced more lump coal than was formerly produced. The firing of the shots has no apparent bad effect on the roof. Fuses are obtained through the company and are furnished to the miners at cost; wire also is furnished to the miners, some 5,000 feet per month being used.

Stripping at the National Colliery

Written for The Colliery Engineer

The D., L. & W. R. R. Co. has opened a strip pit at its National colliery, at Scranton, Pa., from which 150,000 cubic yards of rock and soil have been removed. While the company had been contemplating stripping operations for some time, the beginning of the work was induced by the desire to extinguish a mine fire, which had not yielded to ordinary treatment.

The National colliery is an old one and much of the ground has been worked over. At this point the Big bed approaches close to the surface. One of the distortions of this bed is shown in the wall of the strip pit as illustrated in Fig. 1. At this point the bank is about 60 feet high.

Below the Big bed and separated from it by rock, varying in thickness from 1 to 10 feet, is the New County bed. The Big bed is here from 12 to 20 feet thick and the New County bed about 8 feet thick.

The fire originated in the New County bed at some unknown time in the past and from some unknown cause. The only definite knowledge on the subject is that it has been burning for several years and now covers a space of 300 ft. × 800 ft. Apparently the fire was not caused by ignition from the surface, as the coal under the burnt dump heap was not ignited, though the rock over the coal was calcined by the heat.

Until rather recently, the fire was confined to the New County bed; at

Fig. 2. Two Beds of Coal Exposed in Stripping

least, bore holes did not reveal its presence in the Big bed. It had been found impossible to work in the immediate vicinity of the fire because of the high temperature, and bore holes were put down with the idea of reducing the temperature by increasing the ventilation. They did increase the ventilation but in doing so increased the draft, intensified the fire, and formed channels through which the fire was communicated to the Big bed.

Attempts to extinguish the fire by water have been only partly successful, as the water drains away through the old workings and through fissures and does not submerge all of the burning coal.

At the present time some parts of the fire are being reached by flushing. Drill holes have been sunk from the surface at selected points until eight holes have been drilled, four 14-inch and four 18-inch. All of these reach the New County bed, and average about 90 feet in depth. Openings reached by two of these bore holes have been filled and the third hole is now being flushed.

The operation of flushing is illustrated in Figs. 1 and 3. The surface soil is broken down by jets and washed down to bore holes. The entrance of coarse material is prevented by the grating over the top of the hole. Water is supplied from the Lackawanna River by a two-stage centrifugal pump operated against a head of about 140 feet.

The stripping is done by contract. Speaking generally, stripping in the anthracite country costs from 15 cents to 25 cents per yard for soil and from 25 cents to 35 cents per yard for rock, both in place.

While this operation was undertaken with the immediate purpose of extinguishing this fire, the possibilities revealed by it have induced the company to open another strip pit for the purpose of taking out pillar coal from the Big bed. This operation at present is very small and only about eighteen 2-ton cars per day have been taken out. This number will soon be increased to about 50 cars. At this point the coal has been worked by underground methods. However, a considerable amount of pillar coal still remains near the surface and this can be reached quite economically by stripping. The overburden at the point shown in Fig. 4 is about 15 feet thick and the coal is from 12 to 20 feet thick. This pit is only about 650 feet distant from the breaker.

FIG. 3. FLUSHING SOIL INTO BORE HOLE

FIG. 4. FACE OF BIG BED EXPOSED IN STRIPPING

It is impossible to say how much stripping will be done as there is no means of knowing accurately how much coal remains in the ground. The old maps seem to be either lacking or defective, and prospect drilling is considered impractical, as it would be impossible to outline the coal pillars of the old workings by this method without sinking such a large number of holes as to make the cost of the process prohibitive.

Boiler Water and Its Treatment

Mechanical and Chemical Methods of Removing Injurious Materials from the Water or Rendering Them Harmless

By C. M. Young

THE article on "Boiler Water and Its Troubles" in the preceding issue outlined some of the effects produced upon boilers by impurities in the feed-water. The following article is designed to show how some of these troubles can be mitigated by treatment of the water.

It is possible to divide the methods of treatment roughly into two classes: those employing physical means, and those employing chemical means. However, these two classes overlap so that it is not possible to make a sharp distinction between them. It is possible also to consider chemical treatment under two heads, distinguishing between treatment inside the boiler and outside of it. In any case the method to be employed depends upon the character and quantity of the impurities present, and the quantity of water to be handled.

Physical Treatment.—Solid impurities causing turbidity or muddiness of the water can frequently be removed by settling. This is true only in case the suspension of these solid bodies is due to the movement of the water which prevents their settling. This treatment is purely physical. In some cases these impurities do not settle out completely on standing and it is necessary to add a coagulant to the water. This is some chemical substance which, when added to the water, forms a precipitate which entangles the suspended solid particles and carries them to the bottom with it.

The coagulants most used are aluminum sulphate and ferric sulphate. When these are added to an alkaline water a bulky precipitate of aluminum hydrate or ferric hydrate is formed. If the water is not sufficiently alkaline to cause this precipitation, it is necessary to add an alkali. The use of coagulants is quite common in the treatment of water intended for domestic purposes, but not in treating that intended for boiler uses.

Filtering is sometimes used to removed solid impurities. But in most cases any solid impurities which will not settle out of the water are allowed to go into the boiler, from which they are removed by blowing out.

The use of graphite in boilers may be mentioned among the physical treatments because the graphite has no chemical action. It is sometimes added to boilers to remove and prevent scale. Its action is said to be that the fine particles of graphite carried in suspension in the water enter cracks which are occasionally formed in the scale and prevent the closing of these cracks by the deposition of new scale-forming material in them. In this way cracks spread and the graphite also finds its way between the scale and the metal, with the result that fragments of scale fall off.

Another effect of graphite, which is believed by some to be the most important, is the prevention of the formation of scale. It is thought that the numerous particles of graphite suspended in the water form nuclei upon which part of the incrustants are deposited, thus decreasing the amount deposited on the metal.

A treatment, which embodies both physical and chemical changes, is the heating of feed-water. This is quite commonly done as an economy, because, by the use of exhaust steam to heat the feed-water, a considerable portion of the heat value of the exhaust steam may be saved. This heating of the feed-water results in the depositing of a portion of the scale-forming substances or incrustants. If live steam is used as the heating medium, it is possible to raise the temperature of the feed-water to a considerably higher point than can be attained with exhaust steam. This results in two advantages; first, the water enters the boiler at nearly boiling temperature and the strains produced by the entrance of cold water are prevented. Second, bicarbonate of calcium and magnesium are decomposed, and calcium and magnesium carbonates settle out in the heater. Also the temperature is raised to the point at which calcium sulphate becomes practically insoluble and this also settles out. If sufficient time is allowed in the feed-water heater and the mechanical arrangements are such that the precipitated incrustants are separated from the water, it is possible to remove from the water nearly all of the scale-forming material. Some will, of course, remain in the water, as neither calcium carbonate nor calcium sulphate is entirely insoluble, and a very small amount of scale will be formed in the boiler, as these are deposited with the increasing concentration due to the evaporation of the water. Fig. 1 shows a feed-water heater so designed that the water is exposed in thin trays to hasten precipitation. The trays are easily removed for cleaning whenever necessary.

Chemical Treatments. — Chemical treatments are those in which substances added to the water react chemically with substances already dissolved in the water, forming new substances which are removed or which are less harmful than the original impurities.

As the most common impurities in the feed-water are the incrustants, so the most common treatment is directed toward the removal of these. The treatment is based upon the possibility of such decomposition and recombinations of substances in solution that insoluble substances are formed. One of the most common of such reactions is that between calcium sulphate and any soluble carbonate, such as sodium carbonate. Here the reaction if sodium carbonate is used is

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

The calcium carbonate is practically insoluble, while the remaining sodium sulphate is very soluble.

It would seem to be a very simple matter to add to any water containing calcium sulphate a quantity of sodium carbonate sufficient to precipitate the calcium as carbonate. The difficulty comes from the fact that an excess of sodium carbonate is itself harmful to the boiler, therefore it becomes necessary to add only a sufficient quantity of the reagent to overcome the troubles due to the presence of calcium sulphate. Besides this, the use of an excess of any chemical involves an unnecessary expense.

This necessity of adapting the treatment exactly and carefully to the quality of the water treated, makes the treatment of boiler water a matter for careful study, and the treatment of any water should be attempted only after a careful examination.

The simplest valuable tests which can be applied to water are those for acidity, alkalinity, and hardness. An examination with respect to these three properties alone is not sufficient foundation for a scientific treatment of the water, but will illustrate the procedure necessary.

These tests are made by the addition of standardized liquid reagents. Acidity is commonly determined by the use of a standard solution of $NaOH$, methyl orange or phenolphthalein being used as an indicator. Alkalinity is determined by titration with standard HCl. Alkalinity in natural water is almost always due to carbonates, and in all ordinary cases these are bicarbonates of calcium and magnesium. Total hardness is determined by adding to the water a standard soap solution until a lather formed by shaking will last 5 minutes. This determination is possible because calcium and magnesium compounds in solution form insoluble soaps, and no lather is formed until a certain amount of soluble soap exists in the water. Therefore, enough soap solution must be added to combine with the calcium and magnesium compounds present before any soap can exist in solution in the water.

While in most analytical work the content of the substances sought is expressed in parts per cent., in water analysis the older method of expression as grains per gallon is still largely adhered to. This may easily lead to confusion when waters analyzed in different countries are compared. The British Imperial gallon and United States gallon are not the same, therefore the expression of grains per gallon must be referred to the kind of gallon considered. A calculation is also required when analyses made in other countries are compared with those made in the United States.

The expression of the results of water analysis in parts per million is greatly to be preferred, and this method is coming into use to a great extent. In some cases the results of analyses are expressed in both forms. Parts per million is used instead of parts per cent. because the quantity of substances determined by analysis, commonly found in water, is so small that it would be expressed as a small fraction of a per cent. One grain per U. S. gallon equals 17.138 parts per million.

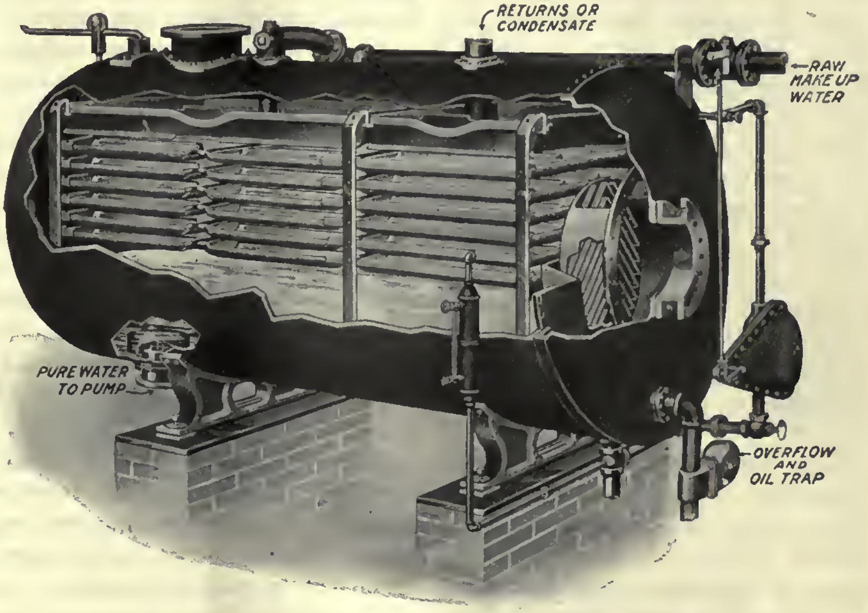


FIG. 1. HOPPES FEED-WATER HEATER

The expression parts per hundred thousand is also very common. Either of these expressions in decimal form is preferable to grains per gallon.

Hardness in grains per gallon is also expressed as degrees of hardness; that is, one degree of hardness is equal to 1 grain of calcium carbonate, or its equivalent in soap-destroying substances, per gallon. One grain of calcium carbonate is equivalent to 1.36 grains calcium sulphate; 1.10 grains calcium chloride; .84 grain magnesium carbonate; 1.20 grains magnesium sulphate; and .95 grain magnesium chloride.

Whenever the treatment of a boiler-water supply is undertaken by a responsible person, the water is carefully examined, not simply in the manner indicated, but it is analyzed for all of its constituents, and the treatment is founded upon

the results of this analysis. In order that the best results possible shall be obtained, it is absolutely necessary that the treatment be exactly suited to the particular water and that the treatment be carefully followed.

Frequently the character of the water changes either rapidly or slowly, and a treatment which is suited to one condition will not be suited to another because the reagents added are not proportioned to the dissolved substances in the water. If this is the case either too little or too much of the chemicals will be used, with the results that the treatment is incomplete and the troubles due to the impurities of the water are only partially removed, or an excess of reagents is added to the water with the result that trouble is caused in the boiler by these added substances.

In some cases the quality of the water supply changes rapidly and frequently, especially when industrial waste is discharged into streams from which boiler water is taken. To illustrate, one large user of water, who when operating at capacity develops 40,000 horsepower, examines the supply twice per day, and the treatment is modified to suit the conditions. On the other hand, some waters such as those from deep wells, are almost constant in composition, and treatment once found satisfactory may be followed without change for a long time.

Among the more common determinations besides those already mentioned are those of sulphates and magnesium. SO_4 is determined by precipitation with barium chloride. Magnesium is determined by precipitation with sodium ammonium phosphate.

It is also desirable to determine the silica, iron and aluminum, alkalies, and chlorides; so that a determination sufficiently complete to serve as a foundation for treatment would show free acidity, iron and aluminum, calcium, magnesium, alkalies (*K* and *Na*) CO_2, SO_4, and *Cl*, and in some cases other substances. It is possible to distribute these elements and groups into hypothetical compounds, and some chemists do so, arranging them for instance into calcium carbonate and calcium sulphate, etc. Such an arrangement is not necessary and is likely to be inaccurate.

The treatment most commonly used is that addressed to the removal of the scale-forming compounds. As we have seen, these are principally carbonates of calcium and magnesium, and calcium sulphate.

Treatment is based upon the formation of insoluble compounds of these metals. It is necessary that the chemical added not only shall produce a compound which is practically insoluble, but that this chemical shall be cheap. There are various insoluble calcium compounds, but calcium is commonly best removed from boiler water as the carbonate, because this is practically insoluble and the reagents necessary to cause the precipitation are very cheap. On the other hand, magnesium can be partly precipitated as the carbonate, but this compound is somewhat soluble and it is therefore desirable to precipitate magnesium as the hydrate, and fortunately this can be done very cheaply.

The carbonate used as a precipitant is sodium carbonate in its crude form of soda ash. The other of the two most common reagents is lime, *CaOH*. Caustic soda, barium compounds, sodium fluoride, trisodium phosphate, and several other substances are also used.

Calcium and magnesium bicarbonates may be precipitated by the addition of sodium carbonate according to the following reactions:

$$CaH_2(CO_3)_2+Na_2CO_3=CaCO_3+2NaHCO_3$$

$$MgH_2(CO_3)_2+Na_2CO_3=MgCO_3+2NaHCO_3$$

and in both cases,

$$2NaHCO_3=Na_2CO_3+CO_2+H_2O$$

They may also be precipitated by the addition of sodium hydrate or calcium hydrate, as follows:

$$CaH_2(CO_3)_2+Ca(OH)_2=2CaCO_3+2H_2O$$

$$CaH_2(CO_3)_2+2NaOH=CaCO_3+Na_2CO_3+2H_2O$$

$$MgH_2(CO_3)_2+2Ca(OH)_2=Mg(OH)_2+2CaCO_3+2H_2O$$

It is apparent that, when calcium hydrate is used as the precipitant, twice as much calcium is precipitated in the form of carbonate as existed in the original water, because the precipitation has been caused by the union of the added calcium with the excess CO_2 of the calcium bicarbonate. If exactly the right amount of calcium hydrate is added, the precipitation will be complete and there will remain in the water only that amount of calcium carbonate which is soluble in water. If sodium hydrate is used, sodium carbonate is formed in the water. This will remain in the water and is itself harmful in the boiler. Whenever the reaction results in the formation of sodium acid carbonate, $NaHCO_3$, this substance breaks down into sodium carbonate, water, and CO_2. Another objection to the use of sodium hydrate instead of calcium hydrate is its greater cost. However, as will be seen later, there are some circumstances in which the formation of sodium carbonate is desirable. Bicarbonate of iron is frequently found, though commonly not in very large quantities. This is treated in the same manner as calcium bicarbonate.

When magnesium bicarbonate is present, the addition of sodium carbonate produces a precipitate of magnesium carbonate. This substance is somewhat soluble and therefore it is necessary to add lime water to precipitate the dissolved magnesium carbonate as magnesium hydrate. Magnesium carbonate would be decomposed by heat.

$$MgCO_3+H_2O=Mg(OH)_2+CO_2$$

The magnesium hydrate is a scale forming substance.

These reactions illustrate the necessity of exact calculations and the adjustment of the treatment to the water.

Calcium sulphate is precipitated by sodium carbonate as follows:

$$CaSO_4+Na_2CO_3=CaCO_3+Na_2SO_4$$

Similar reactions take place with all

soluble calcium compounds but the sulphate is the one commonly met with. It is apparent that the sodium and calcium change places and that there will remain in the water the sodium salt of the acid originally combined with the calcium. All of these sodium compounds are very soluble. They will accumulate in the boiler, and the quantity in solution must be reduced by blowing off the boiler and replacing the water blown out with fresh water.

Another complication resulting from the breaking up of calcium sulphate is the fact that the solubility of calcium sulphate is increased by the presence of the sodium sulphate formed and that the solubility increases with the amount of sodium sulphate in the water. This calcium carbonate, which is dissolved in the solution of sodium sulphate, is deposited in the boiler as scale. This, however, is unavoidable.

Trisodium phosphate is sometimes used to precipitate calcium and magnesium compounds. The advantage of its use is its almost complete removal of the incrustants. However, its cost is considerably greater than that of lime.

The following examples are given to illustrate the care necessary in proportioning the chemicals used in the treatment. They are based upon work done by Kalmann;* embodied in "Analysis and Softening of Boiler Feed-Water" by Edmund Wehrenfennig.

Assume that calcium and magnesium bicarbonates are present and are precipitated by the addition of caustic soda as follows:

$$CaH(Co_3)_2+2NaOH=CaCO_3+Na_2CO_3+2H_2O$$

$$MgH_2(CO_3)_2+4NaOH=Mg(OH)_2+2Na_2CO_3+2H_2O$$

It is apparent that one molecule of sodium carbonate is formed in one case and two in the other. Assume also that the water contains calcium sulphate and that this is to be precipitated by sodium carbonate as follows:

$$CaSO_4+Na_2CO_3=CaCO_3+Na_2SO_4$$

It is also possible to treat this water by adding lime water and soda ash. The lime water will precipitate the calcium and magnesium bicarbonates and the soda ash will precipitate the calcium sulphate.

If too little lime water is used, some of the bicarbonates will not be decomposed and will enter the boiler. If too much is used it will itself form scale in the boiler. If too little soda ash is used, some of the incrustants will remain in the water, and if too much is used it will go into the boiler where the CO_2 will attack the iron.

It is possible to use sodium hydrate and sodium carbonate in such a way as to obtain exactly the result desired. The sodium carbonate resulting from the reaction between calcium and magnesium bicarbonates and caustic soda is utilized to precipitate the calcium sulphate. Assume for example that the water contains calcium sulphate, calcium bicarbonate, and magnesium bicarbonate in the proportions:

1 molecule $CaSO_4$
1 molecule $CaH_2(CO_3)_2$
1 molecule $MgH_2(CO_3)_2$

If we use $NaOH$ to precipitate the bicarbonates we shall have 1 molecule of Na_2CO_3 formed in the reaction with $CaH_2(CO_3)_2$, and 2 molecules in that with $MgH_2(CO_3)_2$. But we have only 1 molecule of $CaSO_4$. Therefore it is necessary to use a combination of $NaOH$ and $CaOH$. By using 2 molecules of each we shall break down and precipitate the bicarbonates and have 1 molecule of Na_2CO_3 to react with the $CaSO_4$.

Suppose we have:

3 molecules $CaSO_4$
1 molecule $CaH_2(CO_3)_2$
1 molecule $MgH_2(CO_3)_2$

We need 3 molecules of Na_2CO_3 to precipitate the $CaSO_4$ and this is the number which will result from the addition of 6 molecules of $NaOH$.

Suppose the water contains:

4 molecules $CaSO_4$
1 molecule $CaH_2(CO_3)_2$
1 molecule $MgH_2(CO_3)_2$

The $CaSO_4$ requires 4 molecules of Na_2CO_3, but only 3 will be formed from the action of the 6 molecules of $NaOH$ necessary to precipitate the bicarbonates. It is necessary in this case to add 1 molecule of Na_2CO_3.

When calcium sulphate alone exists in water, it is precipitated by the use of soda ash. Such a water may result from the action of a stream of mine water containing free sulphuric acid upon the calcium bicarbonate of a stream with which the mine water mingles, or upon limestone. There would then be in this water calcium sulphate and probably also iron and aluminum sulphates.

When free acid is found in the water it is necessary to neutralize it with an alkali. Lime or limestone are the cheapest available substances for this purpose, and the lime acts more rapidly. Sulphuric acid is the only one commonly met with, and it is apparent that the neutralization of this acid with a calcium compound will result in the formation of calcium sulphate. Therefore, it is necessary to use soda ash to precipitate this.

In some cases it is found possible to add reagents to the water in the boiler for the purpose of so combining with the substances dissolved in the water as to prevent the formation of a scale. Where this can be done, the treatment of the water is a very simple matter, as no machinery is required.

Where the water is quite polluted, it is necessary to install a treating plant in which the water can be treated before it is fed to the boilers.

It is apparent that such a plant should possess two characteristics in a high degree. That is, it should be reliable and it should be automatic.

If it is to be automatic it must be mechanically operated, and since the water has to flow into the plant and out again, it is apparent that the motion of the water can be used to operate the mechanical equipment of the plant. What is to be accomplished is the preparation of the reagents, which are commonly soda ash and lime, the accurate proportioning of these, their complete mixture with the water, and the complete

*Mitteilungen des technologischen Gewerbmuseums in Wien, IV. Jahrgang 1890.

separation of the purified water from the precipitate.

The solution of soda ash is prepared by weighing out the required amount of the substance and adding it to a certain amount of water, in which it is quite soluble when agitated. Lime is best used in the form of lime water, because it is impossible to obtain a milk of lime of uniform strength, while a saturated solution of calcium hydrate is constant. This is prepared by agitating quicklime or hydrated lime in water and using the clear liquid after settling.

A great deal of ingenuity has been exercised in making mechanical arrangements which will insure the proper proportioning of the chemicals to the supply of water.

The substances which have been recommended for prevention of scale in boilers, range from oak planks to potatoes. At first thought it would seem absurd to expect results from a great many of the substances which have been used, partly because of the nature of the substances and partly because of the exceedingly small quantity of any active material contained in them. It is possible, however, that some of the results reported were really obtained and really due to the peculiar substances used. The comparatively new branch of chemistry, which deals with colloids, suggests the possibility of prevention of separation of crystalline precipitates by very small amounts of protective colloids. Among these protective colloids are certain vegetable extracts.

There is one other class of troubles which deserves mention, namely those due to electrolytic action. It is well known that when two different metals are immersed in an electrolyte and electrically connected, a current will flow, and that one of the metals will be dissolved. The electrolyte must be something capable of attacking one of the metals, or, if it atacks both, it must attack one more readily than the other.

In the boiler we have brass fittings exposed to the water, and if the water contains anything capable of acting as an electrolyte, for example salt, there will be electrolytic action. Even the difference in composition between the tubes and plates or between the rivets and the plates, or between different parts of the same tube or plate, may cause this action. The common remedy, and one which is successful if properly applied, is to hang a piece of zinc in the boiler. The zinc is attacked and is dissolved instead of the iron. To be successful, the zinc must hang in the water and must be electrically connected to the boiler.

The preceding discussion of boiler water and its troubles and their remedies, is intended to show the importance of careful investigation and the exact fitting of a remedy to the case. It is not full enough to serve as a guide in the planning of treatment for a boiler water supply, but it is hoped that it will indicate the necessity of very careful work when treatment is undertaken, and the desirability of avoiding "cure alls," and of relying upon the services of those who have made a scientific study of the subject.

Fatalities at Coal Mines During 1914

*By Albert H. Fay**

It is gratifying to note that the fatalities in coal mines in the United States in 1914 were 334 less than during the preceding year, the total fatalities being 2,451 as compared with 2,785 for 1913.

The principal causes of accidents that show a material decrease were: Coal-dust explosions, 96 per cent.; haulage, 11 per cent.; and falls of roof and pillar coal, 10.6 per cent. The net decrease, in underground fatalities was 365, or 14 per cent.

There were 331 fatalities due to gas explosions as compared with 91 in 1913, making a net increase of 240. Of the total gas-explosion fatalities, 261 were due to four serious explosions. There were slight increases in accidents due to explosions and electricity. There was also a net increase of 26 fatalities in shaft accidents or 42 per cent., while on the surface the net increase was 5, or about 3 per cent. The net decrease for the year for both underground and surface accidents at coal mines as compared with 1913 was 12 per cent.

The exact figures for the number of men employed are not yet available, but taking the estimates as furnished by the inspectors for part of the states and using the same number of men as employed in 1913 for the other states, gives an estimated total number of employes for the year as 742,868 as compared with 747,644 in 1913. The fatality rate, therefore, becomes 3.30 per 1,000 men employed in 1914 as compared with 3.73 in 1913.

Excluding 1912, when the rate was 3.27 per 1,000 men employed, the 1914 rate of 3.30 per 1,000 is lower than any year since 1903.

While there was a reduction of 12 per cent. in the number of fatalities, there was also a reduction of 10.5 per cent. in the production of coal. The United States Geological Survey estimates the production for 1914 as 510,000,000 short tons as compared with 570,048,125 tons for 1913. The fatality rate per 1,000,000 tons of coal produced in 1913 was 4.89 and in 1914, 4.81. With the exception of 1912, when this rate was 4.41, the 1914 rate is the lowest yet recorded for the United States. The amount of coal produced per fatality in 1914 was 208,078 short tons, which with the exception of 1912 is the largest on record. The production per fatality in 1913 was 204,685 tons; 1912, 226,469; and in 1907, 144,325 tons.

There were 316 lives lost in disasters in which more than five men were killed at one time as compared with 464 in 1913, a net reduction of 148, or 32 per cent. in this class of accidents.

It is not possible to attribute these lower rates to any one particular influence. They may, however, be assigned in part to any one of the following agencies or to a combina-

*Mining Engineer of the United States Bureau of Mines.

tion of all of them: closer and more careful inspection by the state inspectors; better enforcement of laws and regulations by the operators; a realization of the dangers attendant upon the miner in his daily work and his efforts to reduce accidents due to the educational campaign conducted in his behalf; the extended use of safety lamps in doubtful mines; the use of permissible explosives; humidifying dusty mines; first-aid and rescue training which saves lives that might otherwise be lost by reason of injuries received; the enactment of industrial accident compensation laws; and last but not least the spirit of cooperation on the part of all concerned.

Miners Who Don't Mine

There are nearly a hundred thousand employes in the collieries of the anthracite coal fields of Pennsylvania who mine no coal. The exact number in 1913, the latest figures available, was 96,991. The men who mine and load the coal are the miners with state certificates and the miners' laborers. There were 44,346 miners in 1913 and 33,973 miners' laborers. Thus the army of men who are employed at ventilation, transportation, drainage, maintenance, and the preparation of the coal for market outnumbers by over 18,000 the men who are actually mining and loading coal.

Field Coal-Dust Explosion Gallery

A cheap and easily constructed wooden gallery, for demonstrating the explosibility of coal dust at miners' field meets, has been designed and tested with satisfactory results by Messrs. George S. Rice and L. M. Jones, of the Bureau of Mines.

Coal-Dust Explosion Gallery—Ready to Fire

The Explosion

The gallery is constructed of rough 1-inch boards, nailed to timber sets of 3″×4″ material, erected on 6-foot centers. The gallery measures 7 feet wide and 6 feet high, inside of the timber sets, and should be approximately 85 feet long. This length may be reduced somewhat if necessary.

Six inches beneath the roof are placed shelves of 1″×12″ material, which are supported, one at each timber set, by means of two nails driven into each of the uprights.

The gallery is left open at both ends, and 12 feet beyond one end a cannon, consisting of a discarded 9-inch liner from an explosive-testing cannon, which can be supplied by the Bureau of Mines upon payment of transportation charges, is set on timbers so as to be a foot above the ground level with the bore hole parallel to the axis of the gallery. From in front of the cannon, and extending to a point 3 feet within the gallery, a platform on which to place dust is erected. A heavy wire is fastened to an eyebolt, screwed into the front of the cannon, and is stretched over all of the shelves, being attached to each by a nail on the top side near the edge away from the cannon. The cannon is braced loosely by a timber, extending from it to a pile of dirt in the rear, so as to allow a recoil of from 1 foot to 2 feet, which by means of the heavy wire attached to the dust shelves will effect the dumping of the dust when the cannon is fired. Each shelf should be heaped with the dust to be tested and placed on the four nails of each timber set, so as to be nicely balanced thereon and yet to be easily dislodged by the recoil of the cannon. More of the dust should also be heaped on the platform in front of the cannon, extending from the cannon for about 15 feet, so as to propagate the flame from the cannon to the dust within the gallery. Roughly, 200 pounds of coal dust will be required for each demonstration. Cannon should be charged with 1 pound of "FFF" black powder tamped with 3 pounds of clay.

When the cannon is fired, all of the dust shelves should fall so as to prepare a cloud for the propagation of the flame throughout the gallery. If the coal dust is inflammable, the flame will pass along the dust in front of the gallery and will then be sent through the cracks between the boards of the sides and roof and finally emerge at the opposite end of the gallery.

Wet the boards before each test to prevent their taking fire.

Steel-Wire Hoisting Ropes

Rule for Finding the Load Stress and the Required Diameter, Together With a Practical Illustration

By F. W. Sperr*

THE working load in tons of 2,000 pounds, that a hoisting rope made of the best plow steel, is capable of sustaining, is eleven times the square of the diameter of the rope in inches, after due allowance has been made for bending stress on account of sheaves and winding drum and for factor of safety. A part of this load is the weight of the rope itself.

The weight of the rope is 1.58 pounds per foot in length multiplied by the square of the diameter. As the diameter increases, the load increases, with weight of mineral and receptacle and speed of hoisting remaining constant.

By the load stress we mean the resistance to be overcome by the rope in moving the load of mineral; it consists of the weight of the mineral, the weight of the receptacle, the weight of the rope, the track friction, the journal friction of the sheaves and pulleys, and the mass acceleration.

The resistance of the sheave friction is dependent upon the resultant of all the forces acting upon the journal bearings. An exact analysis would involve the weight of the sheave acting vertically, the pull of the rope in the direction of the mine, and the pull in the direction toward the winding drum. The weight of the sheave and the difference in pull between the two directions of the rope line will have but little influence upon the amount of friction. The problem is simplified and the results are practically correct if we neglect the weight of the sheave and consider the pull equal in the two directions.

For the derivation of the rule to express the value of the load stress on a hoisting rope in terms of known quantities:

Let W_1 = the weight in tons attached to the rope;

W_2 = the weight in tons of rope suspended;

W_3 = the resistance in tons of the mass W_1+W_2 together with the resistance due to acceleration and to the friction on the track or in the guides;

$L=W_3+$ the friction of the sheaves expressed in tons. This is the load stress on the rope;

S = the speed of winding in feet per second after the normal speed of the engine has been attained;

t = the time in seconds required to attain the speed S, and suppose this to be equal to the time required to come to a stop from full speed;

T = the total time of winding in seconds;

D = the depth of the shaft in feet;

ϕ = the angle of the shaft below the horizontal;

a = the angle between the two lines of the rope on either side of the sheave;

$\Sigma = \cos \frac{1}{2} a$ = the sum of the cosines of one half of each of the different angles produced by the different sheaves in the line of the rope;

f_s = the coefficient of sheave friction;

f_t = the coefficient of track friction;

d_1 = the theoretical diameter of the rope in inches;

d_2 = the commercial diameter of the rope in inches.

First, find the value of W_3 as follows:

$$W_3=(W_1+W_2)\sin\phi+f_t\,(W_1+W_2)(\cos\phi+.05)+\frac{(W_1+W_2)\,S}{g\,t}.$$

g being the gravity factor, approximately 32.16.

Find the value of $\sin\phi+f_t\,(\cos\phi+.05)+\frac{S}{g\,t}$ and let this value be represented by A. The term .05 makes allowance for friction in the guides when $\phi=90$ degrees.

The friction factors are found to be somewhat variable under a multitude of varying influences. Approximate average values may be assigned as follows:

$f_s=.015$;

$f_t=.1$ in the case of a bucket, cage, or skip running on skids or in guides;

$f_t=.015$ in the case of a skip on wheels running on steel rails.

The value of S may be found with sufficient accuracy by assuming a uniform acceleration during a certain period, then a uniform speed during a certain other period, and then a uniform retardation during a final period equal to the period of acceleration.

This will make $S=\frac{D}{T-t}$ for winding with a cylindrical drum.

After finding the value of A, write $W_3=A\,(W_2+W_1)$, and sheave friction $=2\,A\,f_s\,(W_1+W_2)\,\Sigma\cos\frac{1}{2}a$. Then by summation, $L=A\,(W_1+W_2)(1+2\,f_s\,\Sigma\cos\frac{1}{2}a)$ (1). And it now becomes necessary to eliminate the unknown term W_2 in order to express the value of L directly in known terms.

$$W_2=\frac{1.58\,d_1^2\,D}{2{,}000}=.00079\,d_1^2\,D \quad (2).$$

Substituting $\frac{1}{11}L$ for d_1^2.

$W_2=.000072\,L\,D$ (3). By substituting this value of W_2 in the equation (1) for L, and solving for L.

$$L=\frac{A\,W_1\,(1+2\,f_s\,\Sigma\cos\frac{1}{2}a)}{1-.000072AD\,(1+2f_s\Sigma\cos\frac{1}{2}a)}$$

in which all the terms are known from the stated conditions (4).

$d_1=\sqrt{(\frac{1}{11}L)}$. Probably this value of d_1 is not a commercial diameter. The commercial diameters vary by $\frac{1}{16}$ inch from $\frac{3}{8}$ inch to $\frac{5}{8}$ inch, by

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$\frac{1}{8}$ inch from $\frac{5}{8}$ inch to $1\frac{3}{4}$ inches, and by $\frac{1}{4}$ inch from $1\frac{3}{4}$ inches to $2\frac{1}{4}$ inches.

Make d_2 = the commercial diameter next higher than d_1, unless the latter should happen to be found an exact commercial diameter. Then with d_2 fixed, $W_2=\frac{1.58\,d_2^2\,D.}{2{,}000}$ (5).

When this value of W_2 is substituted in equation (1) and L_1 is made the corrected load stress,

$$L_1=A\left(W_1+\frac{1.58\,d_2^2\,D}{2{,}000}\right)(1+2\,f.\,\Sigma \cos\tfrac{1}{2}\,a). \quad (6).$$

For example, Fig. 1, if the angle of the shaft is 70 degrees, the depth 4,500

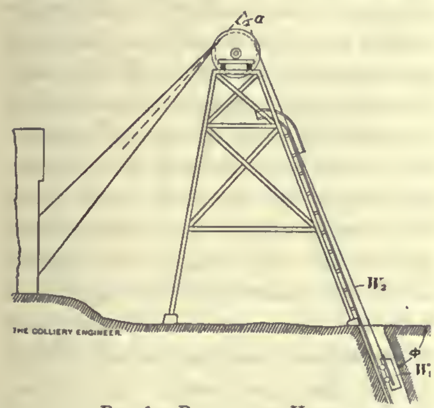


FIG. 1. DIAGRAM OF HOIST

feet, the time of hoisting 70 seconds from starting to stopping, the time to develop uniform engine speed 10 seconds, the angle between the rope lines over the head-sheave 60 degrees, the weight of cage and loaded car totals 11 tons,

$$W_1=11;$$
$$t=10;$$
$$T=70;$$
$$D=4{,}500;$$
$$\phi=70°;$$
$$a=60°;$$
$$S=\frac{4{,}500}{60}=75 \text{ ft. sec.}$$

Then $A=\sin\ 70°+.015\ (\cos\ 70°+.05)+\frac{75}{321.6}=1.1785.$

Let $B=1+2f.\ \Sigma \cos\frac{1}{2}\,a;$

$$B=1+.03\cos 30=1.026.$$

Then,

(1) $L=1.1785\times 1.026\,(W_1+W_2) = 1.2092\,(W_1+W_2);$

(3) $W_2=.000072\times 4{,}500\ L=.324\ L;$

(4) $L=\frac{1.2092\times 11}{1-.324\times 1.2092}=21.88$ tons;

$$d_1=\sqrt{\frac{21.88}{11}}=1.41 \text{ inches.}$$

Make $d_2=1\frac{1}{2}$ inches, the commercial diameter of the rope that will be required to do the work.

(5) $L_1=1.2092\times\left(11+\frac{1.58\times 2.25\times 4{,}500}{2{,}000}\right)=22.97$ tons, the load stress on the rope at starting.

Safety Inspection System of the Susquehanna Coal Co.

*By Edwin C. Curtis**

THE employment of safety inspectors in the mines of the Susquehanna Coal Co. was commenced on August 1, 1913. There are at present 50 of these inspectors employed in the various mines of the company. In the Wyoming Division there are 24, whose constant and only duty is to look after safety. They are sometimes called "the first aid to the uninjured."

These men are directly under the charge of the mine foremen, to whom they make a report of the precautions taken in the interest of safety during the day. They report to the fire boss in the morning and he tells them of the places that are dangerous, as he noted when he made his morning examinations, and of the orders he issued to the miners when they reported to him.

It is the safety inspector's duty then, to visit these dangerous places first, and see whether or not the miner has complied with the orders issued by the fire boss. He is also supposed to examine the miners' places for gas and to test the roof every time he enters a place. He also examines the traveling roads, and is constantly on the alert for danger from any source; in other words, he is looking for trouble.

If the miner has not started to comply with orders previously issued to him, the safety inspector directs and instructs him how to make himself safe, or takes such action as the circumstances warrant, but all for safety.

*District Safety Inspector, Wyoming Division, Susquehanna Coal Co. Instructor of Practical Mining, Nanticoke Vocational Schools. From a paper on "Safety First," read before Nanticoke District Mine Institute, February 20, 1915.

After he has visited the dangerous places he inspects all the places, traveling roads, manways, and second openings, in his district, and makes note of conditions and instructs the men how to take care of their places. If he finds a dangerous condition existing whereby an accident is liable to occur, he has it remedied immediately, or orders the place stopped until the necessary repairs are made.

He also notes whether the mine law is complied with in regard to safety holes and clearance for the passing of moving cars, whether abandoned workings are fenced, whether head-blocks and safety catches are in position, whether cars are properly blocked, and whether men travel on places prohibited by law, whether second openings are available and in good condition, and whether timber or materials are unloaded too close to the road. He is also familiar with the various escape ways and return airways so that he can lead the men out in case an accident happens to the hoisting machinery. He also makes note of places that are in need of timber, and reports them to the proper official.

There are also placed in conspicuous places in and about the mines, various signs calling the attention of the men to the dangers that surround them in their working faces and along the traveling roads. Signs are also placed showing the men the different manways, second openings and means of exit from the mines.

Captions on pay checks and due bills are constantly calling the men to be aware of the dangerous conditions under which they labor for their sustenance. Electric signs are displayed at the entrance of every colliery yard, and in the most conspicuous places on the outside, forever telling the men to be careful. Forever they are appealing to the man's higher and nobler side warning him to be careful, not merely for himself alone, but also for his wife and family and his fellow workmen.

The safety-first movement not only applies to the working men but also to the officials of the company. Meetings are held frequently to discuss causes and conditions that produced accidents, and precautions and suggestions are offered for prevention of similar accidents.

Bulletins are issued and sent to the different superintendents, each of whom in turn sends copies to each mine foreman in his district. The mine foreman then calls his assistants, fire bosses, and safety inspectors together, and reads the bulletin on the causes of accidents and methods to be used to prevent them, which precautions are strictly enforced.

Examinations on mine law, for the officials, are held at stated periods, at which examinations the attendance of every man employed in an official capacity by the company is demanded.

Therefore it can be seen that education and efficiency are demanded of men, and officials alike, for the prevention of accidents in our coal mines.

It is not the intention of the writer of this article to say that an efficient or educated miner never gets hurt. Sometimes unfortunately such an accident happens, but it is usually an accident that was unavoidable, not due to ignorance of danger, or careless methods used.

It is the consensus of opinion that efficiency is the largest factor that contributes to safety. Man was not born efficient. He may have some physical or mental characteristics that lead to efficiency, but to become efficient men must be trained and educated to do their work in a systematic and intelligent manner, if accidents are ever to be reduced to the minimum.

The originators of the safety-first movement and the men who are trying to prevent accidents in and around the mines, are endeavoring to do this. But the man at the coal face or along the road, or the driver, or door boy, or whoever he may be, must also do his part in this great movement.

Gas Caps and Gas Discharges

*By John Thompson**

In examining for gas in a certain heading on one occasion, the writer was surprised to discover a twofold combination of a gas cap. The flame on the testing lamp was reduced to a non-luminous one. Directly over the non-luminous flame was a cap having a brown or reddish-brown tint, and surrounding and above this peculiar cap was the ordinary gas cap.

This unusual cap puzzled the writer and he naturally wondered what conditions were the cause of such a peculiar circumstance. His surprise was intensified when upon other subsequent occasions he observed the same gas cap combination at the same place and also in an adjoining heading. He has also observed this reddish-brown cap when no ordinary gas cap could be discerned. When making examinations at the places mentioned the writer has observed tongues of flame, of the same reddish-brown tint, shoot up from the non-luminous cap and for some distance within the ordinary gas cap, and he assumes there is an undoubted connection between these transitory tongues and the more stable internal reddish-brown cap.

In a coal heading where gas is present and a cap is shown and where dust particles are in suspension in the air, it is possible to see the flame of such particles shoot up from the non-luminous flame and within the gas cap, and generally ascend to the apex of the cap, but the reddish-brown tongues of flame did not usually do so, but only ascended for a limited distance within the cap. Moreover, the places where these flames were observed were wet to such an extent as to prevent dust particles floating in the air.

This phenomenon was observed with a Wolf naphtha lamp, admirably adapted for such a purpose.

*Read, March 27, before the South Staffordshire, Warwickshire, and Worcestershire branch of the National Association of Colliery Managers.—*Colliery Guardian.*

On one occasion within the writer's experience a heading had been fenced off owing to the presence of gas at its extreme end. The heading was ventilated by a 7-horsepower fan exhausting air from a range of air pipes 12 inches in diameter and about 450 yards in length. Being familiar with the place, the writer knew that the gas was issuing from a cavity in the roof about 30 yards from the extreme end of the heading. He went to examine the cavity and upon reducing the flame of his lamp to a non-luminous one, found to his surprise that there was hardly any gas to be observed. But in the course of a few seconds he observed gas beginning to show, and the cap formed to steadily increase until it indicated a percentage of nearly five; but after attaining this size the cap began to diminish until there was barely visible any indication of gas at all. As long as the writer could take observations, this rise and fall of the gas cap was repeated, and its repetition was somewhat similar to the crest and trough of a wave-like movement. Sometimes the gas cap rose to such an extent as to indicate the presence of gas at its lowest explosive point, and the writer was fortunately able to observe several alternations of the rise and fall of the cap before his light was eventually extinguished.

To prove the sensitiveness of gas to pressure the following incident will serve as a good example. In a certain heading a little gas was discharging from a break in the roof. As water also issued from the same break, the discharging gas made a noise of effervescence, and the water had a frothy appearance. Nearby was a pump operated by compressed air. As soon as the pump began to work and exhaust air was driven from its cylinder, the gas ceased to discharge from the crevice. The added pressure of the exhaust air to that of the atmosphere in that locality was enough to counterbalance the pent-up energy of the gas in the crevice.

From a practical standpoint the variability of a gas discharge is

somewhat important; for a man examining for gas in a cavity from which it exudes, might conclude that no gas was present if he happened to make his observation at the psychological moment when the discharge of gas was at its minimum depression, and he would justifiably conclude there was no immediate danger. But a man making another observation immediately after, might find the discharge at its maximum and he might rightly conclude that the evolution of dangerous conditions was possible.

The higher the percentage of gas present in the air-current of a mine, the more readily it becomes visible upon the flame of the testing lamp and as the percentage of gas present becomes relatively lower, it requires a relatively lower flame upon the lamp to discern and render visible its cap. To detect a small quantity of gas it is necessary to reduce the flame upon the lamp to a non-luminous one, whereas if the percentage of gas in the air-current is abnormally high it can be seen burning on the ordinary flame of the lamp.

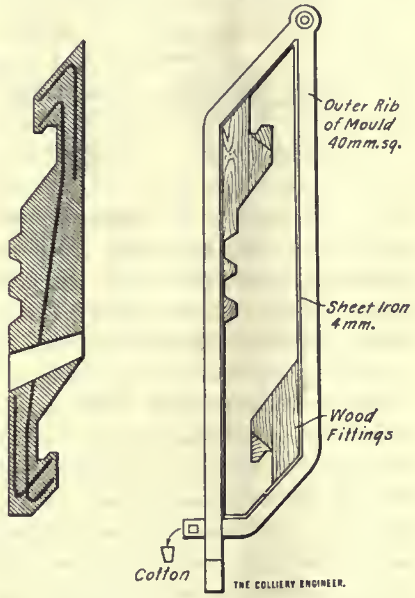
Sometimes conditions may be prevalent that render it a somewhat risky proceeding to reduce the flame to a non-luminous one, seeing that the extinction of the observer's light may place him in difficult circumstances, and the extinguishing of a light is so easy with a reduced lamp flame.

The writer has sometimes endeavored to ascertain whether it is possible to obtain an approximate idea as to the quantity of gas present by observing the height of the luminous flame at the moment when the gas cap vanishes or loses its visibility. From his observations he has come to the conclusion, somewhat empirically he admits, that when the gas cap vanishes with a luminous flame of about ¼ of an inch, there is present nearly 2½ per cent. of gas; and when the gas cap vanishes with a luminous flame of about ⅜ of an inch, there is present in the air slightly more than 2½ per cent. of gas, the limit fixed by statute as a demarcation of the danger line.

Ferro-Concrete Shaft Linings

Plan of Using Segments of Z Section, Suggested by a French Engineer, M. Gillieaux

OF ALL the systems employed for lining shafts, ferro-concrete has the advantage of being the cheapest in proportion to the resistant properties of the material, and to the space occupied by the lining, a thickness of 8 to 10 inches being as efficient as 14 inches of brickwork.



VERTICAL SECTION OF Z SEGMENT VERTICAL SECTION OF MOLD

The usual plan of using segments with butt top and bottom joints is attended with certain inconveniences, including leaky joints and the necessity for providing temporary scaffolding when, as is generally the case, the work of lining the shaft is commenced at the top and continued downward. To obviate these defects, the author has devised a form of construction in which the segments are of Z section, each being hooked on to the next higher member, and thus making closer joints than are ordinarily possible.

A strong crown ring is fixed in the rock at the head of the lining, and when the sinking has sufficiently progressed a series of the Z-shaped segments is suspended from this ring, to form the first ring of tubbing. As the sinking proceeds fresh rings of segments are hooked on to those already in position. When several rings have been set up, the annular space between the lining and the shaft wall is plugged, and a semifluid mixture of cement and sand is injected into the cavity through the holes provided in the segments. When the cement has set, it binds the lining firmly to the rock, and fresh segments can be hung on below without fear of straining the upper portion.

The reason for the adoption of the S or Z section was that this type is the one most suitable for obtaining satisfactory autosuspension, though in certain special cases ribs of X or I section, arranged at right angles to the shaft wall, might be preferable.

Reinforcement consists of S irons, extending from the top to the bottom rib of the segment, with auxiliary simple hooks, arranged symmetrically to the first named, in the nose pieces and narrow or throat sections. With regard to the weight and dimensions, it is advantageous that each unit should cover the largest possible surface, within reasonable limits. It is usually not desirable for the weight of a segment to exceed 600 or 700 pounds and the corresponding superficial area to be about 7 square feet.

To facilitate the injection of thick grouting, the injecting holes are tapered outward, and sloped downward. Their position should be as low down in the segment as is practicable, and their diameter should correspond to that of the feed-pipe.

To enable segments to be hooked on to those above, a small amount of play must be allowed for between the upper sloping surface of the top rib and the corresponding slope of the bottom recess into which it fits, so that the nose can slip into the

*Read before the Association des Ingenieurs sortis de l'Ecole Polytechnique de Bruxelles.

channel prepared for it without difficulty. The same applies to the lower slope of the bottom rib and the corresponding lower slope of the recess in the upper portion of the next lower segment.

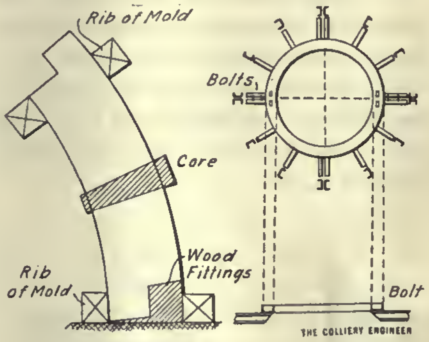
The key segment of a ring is necessarily of somewhat different shape to the rest, in order to facilitate its insertion. With this object, the inner flange on one lateral edge of the first segment of each ring is suppressed, the edge being beveled inwards. This arrangement, it is true, results in a weak spot in each ring; but this effect may be minimized by staggering these joints.

The segments are cast in ordinary molds, wooden liners being inserted to produce the necessary recesses and to shape the nose pieces. To obviate the need for cutting through the segments to provide lodgments for the ends of the buntons, a prismatic core of slightly larger size may be inserted into each mold of those segments that will support the buntons. The passage thus formed in each block may be used for the introduction of the cement grouting, or the reinforcing irons may be suppressed at the point where the hole is intended to be cut.

The concrete is introduced into the molds in an almost dry state and is well rammed. The reinforcing irons are inserted one by one, and as soon as the segment is completed it is taken out of the mold.

The suspension ring or crown consists of a channel-iron ring with external radial arms horizontally bedded in a thick layer of concrete at the top of the shaft. Tie-rods (old rails, etc.) are sometimes driven through the unusued cement channels in the segments into the rock. Being subsequently embedded in the grouting, they serve as a reinforcement, and they may, to some extent, play the part of spikes holding the segments in place. In order to prevent or correct any deformation of the circular section of the shaft, it is well to insert after each segment a rigid ring of the same diameter as the shaft.

The segments are lowered down the shaft, and put into position by means of a cradle. The latter is triangular in shape, and curved at the bottom in order to form a support for the block. To prevent the latter from slipping, a hinged ledge at the bottom of the cradle is turned up and secured by means of a wire



Cross-Section Through Mold   Suspension Ring

cord. To detach the segment from the rope; the retaining cord is loosened, and when the rope is slackened the cradle swings to the center of the shaft, ready to be hoisted up again.

Before commencing the actual operation of sinking the shaft, a circular hole is dug for the foundation of the suspension ring. Then, when the shaft has been sunk a few yards, the ring is put into position in the center of the hole, and the radial arms or beams on which it rests are laid with their ends carefully secured in the groove provided for that purpose. The upper hooks of the first ring of tubbing are then lowered into the channel of the suspension ring, which has been filled with thick cement. The weight of the segments forces out the cement, which runs down and fills up all the interstices. Each segment is then tested to see that it hangs vertically, and, if not, is wedged until it does. If the cavity behind the segments is so large at any point that too much cement would be required to fill it up, a grid of cross-bars is laid on the tie-bars, to support a number of stones (put in from the open side), which the cement then binds together into a solid mass. The closing segment is put in at a point where the rear cavity is the smallest.

To prevent the injected grouting from escaping at the vertical joints of the segments, these joints are caulked with tarred hemp or tow. In putting in the second ring of tubbing, the vertical joints should be staggered with relation to those of the first ring, and similarly with all subsequent rings. As each segment is hung onto the one above, a thick cement is placed in the recess in the latter, and will then fill up the whole of the joint and make it tight. When three or four rings have been put in, the injection of grouting is begun, this being poured in at the top between the crown and standing rock, for the upper ring, and introduced through the special channels left for that purpose in the others. To close the open space at the bottom of the lowest ring, a temporary staging is erected underneath. As each segment is put in, and this staging is caulked, a layer of tow is placed on it and covered with a little concrete. The success of the injection and the rate at which it can be performed depend on the care with which the staging is fixed.

To enable the grouting to be poured into the space behind the first of the next set of rings, wooden plugs are inserted through the central channels of the lowest ring, which plugs reach down as far as the tow on the staging, and form cores. When these are drawn out, a free passage to the next ring is left for the concrete, which should be sufficiently fluid to prevent choking the passages.

When the injection is completed, sinking is recommenced, the base of the existing lining being protected, if necessary, with temporary timbering. Fresh rings of tubbing are put in, in the same way as before, as sinking progresses.

From the technical standpoint, the Z segments give a perfectly homogeneous lining, and are cheap, the cost of temporary lining being saved. The system enables all the shaft fittings, such as ladders, ventilating pipes, compressed-air pipes, etc., to be placed in their permanent position as sinking proceeds; and

the rock water being held back, the cost of pumping out the shaft is reduced, a whole series of small economies being effected which, in the aggregate, considerably lessens the relative expense of the installaton.

Gas-Detecting Apparatus*

Firedamp occasionally contains other gases than methane and varying amounts of hydrogen, carbon dioxide, and air, but so rarely as to justify the common assumption that firedamp is a mixture of methane and air.

While it is true that some of these gases occasionally found have a lower explosive limit than methane, it is also true that they give better caps for the same percentage of gas, and therefore, if estimated as methane, there is no great probability of their occurring unobserved in sufficient quantities to cause damage.

With certain possible exceptions there are only two methods of gas detection having any practical value: first, flame in some form of safety lamp; second, analysis.

Methods suggested and in operation may be classed under four heads. First, flame testers, including safety lamps of various types. Most of these serve a double purpose, giving light and at the same time indicating the presence of gas, and can, with care, test down to say 2 per cent. or even 1 per cent. Second, apparatus depending on the rate of diffusion of gases, including appliances of the Ansell, McCutcheon, and Webster types. Third, apparatus depending on the slow or rapid combustion of the gas, and the resulting increase in temperature, decrease in pressure, or decrease in volume measured. Fourth, electrical detectors or "hot-wire instruments."

Flame Testers.—There is still a persistent tendency to estimate the amount of gas present from the height of the cap. Estimates thus made may be misleading because of variable conditions, such as height of testing flame used, kind of oil, and size of wick. For the higher percentages, especially those above 3 or 3½ per cent., it is possible to obtain great variations in the height of the cap by relatively small variations in the height of the testing flame. It is much more reliable to judge from the density of the cap. It has been found that any one with ordinary vision, with most lamps in use at the present time, could easily see as low as 1 per cent., and with one of the more modern lamps burning lighter fuel could detect less than 1 per cent.

Apparatus Depending on Rate of Diffusion.—The rate of diffusion of gases varies as the square root of the density. Any apparatus of this kind, even if calibrated with methane, could not give reliable results in a mine where other gases are present unless these gases could be removed before passing through the porous medium.

Indicators depending on combustion of the methane present and the resulting increase in temperature, decrease in pressure, or decrease in volume, include probably the most accurate forms of instruments for the detection of methane, but unfortunately most of them are suitable only for laboratory work or for work on the surface, and so far as known none of them have been successful for use underground by ordinary persons.

Electrical Detectors.—These really come under head of combustion apparatus. They differ from the Chatelier and Haldane apparatus, both of which also use an electric current, in that instead of measuring the change produced in the gas sample itself, the physical alteration produced in a hot wire due to the combustion of the gas is measured.

Such an instrument as the Liveing indicator is satisfactory for a considerable time in a laboratory or on the surface, but it is too clumsy to carry underground. Also the zero rating alters after a time.

The recently invented Ralph firedamp meter is much more portable, more easily handled, more reliable, and practically independent of the personal element. This has been tried in the laboratory with satisfactory results. None of these instruments has had a prolonged trial underground. It perhaps may be said that the principal use for such apparatus is testing for gas in mines in which electrical safety lamps are used and the entire elimination of anything in the nature of a flame is important.

*From a lecture by W. G. McMillan, Professor of Mining, University College, Nottingham.

35-11—5

Water From Anthracite Mines

The quantity of water that must be pumped and hoisted out of the anthracite mines of Pennsylvania has increased nearly 10 per cent. in the last 10 years, and will continue to increase, making the mining of anthracite constantly more expensive. It has been computed that every ton of coal removed from the mines involves the removal of a ton of water every year thereafter until the mine and all workings connected with it are worked out and abandoned.

In 1904 there were 846 pumps below ground and 10 years later there were 929 pumps, many of them of greater capacity than the old ones they replaced, beside the huge water hoists. In 1904 the capacity of these pumps was 745,690 gallons per minute as against the 1,037,009 gallons per minute recorded as their capacity in the last annual report of the Pennsylvania Department of Mines.

All of this pumping capacity, necessary to meet periods of "heavy water," is not in use all the time. The quantity of water actually delivered at the surface in 1904 was 446,120 gallons per minute. Ten years later it was 489,600 gallons per minute, or about 250,000,000,000 gallons a year. This is equal to approximately 950,000,000 tons a year, or thirteen and a half times as many tons as the total output of coal.

WITH THE EDITORS

The Cover Page

THE cover page this month shows an explosion in the gallery designed by the United States Bureau of Mines for use at first-aid contests and whenever it is desirable to produce, on the surface, some of the phenomena of a mine explosion and the consequent conditions. This gallery ought to be of practical value in showing the preparedness of first-aid teams and should also be of interest in adding to the realism of contests.

On Encouraging Thrift

IT WOULD be a very interesting thing to know what part of a miner's wages is saved and put to work for him. When the coal business is at all good the pay of a miner is more than he needs for the decent support of a family. What becomes of the rest? Some save it, but more waste it.

The frugal, thrifty man is respected. He does not need to be miserly, but he must not be wasteful, for though a free spender may have many companions, he will not have many sincere admirers. The man who saves for some object works more regularly and carefully than the spendthrift; he is more dependable. He is self-respecting and commands respect.

Much is being done to improve the living conditions of miners. Houses are better than they were. There are gardens in some camps, with free seeds and free instruction in gardening. There are playgrounds and moving picture theaters. These things go far toward improving the life of the miner, and the companies that are doing them are receiving benefits in steadiness and contentedness second in importance only to the knowledge that something of the old conflict between laborer and employer is disappearing.

Is it not possible to go farther than this and encourage saving? Talking and urging would do little good. Telling a child to save pennies, when he sees candy to buy and nothing else to do with the pennies, does not persuade him to save them. But if he has a bank to put them in where he can see them accumulate, and knows that he can use them when some greater want is felt, he really learns to save. The same thing is largely true of adults. They need to watch the savings accumulate and know that, while they add to the pile, it is doing work and earning interest.

Some coal mining towns offer such incentives, but this is not often the case in purely mining towns. It would seem to be possible, at least, to do what banks do, pay interests on deposits. And there can be no doubt that the opportunity to save and receive interest on savings would be welcomed by many miners. It would lead to greater contentment and greater industry and there would be less willingness to interrupt the savings by taking a day off now and then. Also a thrifty, contented camp would offer an uninviting field to the agitator.

It might be possible to go even further than the promotion of saving and offer some safe field of investment. It is good for a man to buy something if the thing bought will be of permanent use to him, or something that he can turn into money again without loss. It would certainly be worth while, considered as a matter of business only, to encourage saving and investment on the part of the miner. There is many an operator who would find a much greater reward in knowing that he was helping to make men self-respecting, better men, and better citizens.

Scientific Management

EACH and every workman about a mine has a certain duty to perform. There are right and wrong ways to do everything. The fundamental principle of all work that is to be executed correctly, is an intelligent knowledge of that work.

When a man starts laying track or timbering, for instance, in the mines for his first time—is he accompanied by a finished track layer or timberman who acts as an instructor for a day or two?

When a certified coal miner is assigned to a room and told to mine the coal there, does the company appoint a man to stay with him for one or two shifts to see that he cuts the coal in accordance with its rules and regulations? "He is supposed to know how to do these things" the company will say.

Yes, but does he know?

Doubtless there are superintendents and mine foremen by the scores, yes hundreds, who can cite instances where accidents might have been avoided had this or that workman known his business as he ought.

In view of such conditions existing in and about our coal mines, there needs to be something added to the many safety campaigns now in existence. Safety should be the goal of every organization, but safety is only predominant when every factor leading to its consum-

mation is conscientiously attended to. Unquestionably, the most potent factor is the human element. Then, with that in mind, develop that factor first, insure not its perfection, for that would be unreal, but its cultivation along scientific lines and the others will take care of themselves.

In a recent issue of a popular magazine is an interesting article on "Scientific Management." The subject is broadly discussed and the beneficial results obtained in the Link-Belt Company's shops, clearly outlined. Men producing 60 to 80 pieces of work per day under the previous system, now turn out more than double that number and receive proportionately greater wages. There is no driving, no speeding up to make a record, only the application of scientific ways and means together with a clear brain and an industrious nature on the part of the workman.

The results are amazing, so why not apply it to coal mining? At first thought, the manager thinks of the arduous work that daily falls to the lot of some of the men about the mines, and he says "it can't be done." *But it can.*

Economy in Steam Production at Mines

THE day of "rule-of-thumb" methods of arriving at costs at coal mines has long since passed. Under present conditions the savings due to careful attention to economical details frequently mean the difference between profit and loss, and in all cases they mean either a diminished loss or increased profits.

One of the last things to receive attention, and it is by no means an unimportant means of waste at a coal mine, is the steam plant. The excessive use of fuel means the loss of its cost plus the profit, if any, on the excess, and the increased cost of handling fuel and ashes. Unnecessary waste in repairs, due to carelessness, and in supplies, are also worthy of attention.

On another page we publish an article on "Keeping Power Plant Accounts," by Charles J. Mason, which we commend to mine managers generally. The system described by Mr. Mason is simple and can easily be adapted for use at any mine. It has been in use for years at a large power plant, and Mr. Mason personally kept the accounts for some ten years with excellent results.

Kentucky Mining Institute

The summer meeting of the Kentucky Mining Institute was a success. It was held on May 14 and 15, at Pineville, in the southeastern corner of the state, where the valleys are narrow and the hills rise 2,000 feet above the streams.

The meeting opened with an excursion on a special train provided by the Louisville & Nashville Railroad. The trip occupied all of the first day, and extended from the mines at Straight Creek to Benham. At Coxton the party stopped for a delightful lunch in the shade of apple trees. The hosts were Mr. K. U. Meguire, president of the Harlan Coal Mining Co., and Mr. John W. Williams, president of the Lick Branch Coal Co. Music was furnished by an excellent band from the Arjay mine of the Continental Coal Corporation. About 200 people were in the party.

Saturday morning a session was held for the reading of papers and the transaction of business. Mr. F. P. Wright, general manager of the Crescent Coal Co. and president of the Western Kentucky Operators' Association, was elected president for the following year. Prof. Ivan P. Tashof, of the State University, was reelected secretary-treasurer.

The next meeting will be held in December, probably in Lexington. Papers were presented as follows:

Address by the Mayor of Pineville, Hon. White L. Moss.

Presentation of papers:

"Good Roads Legislation and Its Effects on Southeastern Kentucky," State Senator Joe F. Bosworth, Middlesboro, Ky.

"The Coals of Eastern Kentucky," Frank Haas, consulting engineer, Consolidation Coal Co., Fairmont, W. Va.

"The Goodman Straight-Face Mining Machine," H. H. Small, sales manager, Goodman Mfg. Co., Chicago, Ill.

"The Coal Fields of Harlan County, Kentucky," Walter R. Peck, consulting engineer, Big Stone Gap, Va.

"The Coal Fields of Perry County, Kentucky," William J. Von Borries, consulting engineer, Louisville, Ky.

"The Growth of the Coal Industry in Eastern Kentucky, and What This Means to Louisville Manufacturing and Commercial Interests," Frank H. Cassell, sales director, Belknap Hardware and Mfg. Co., Louisville, Ky.

In the afternoon a state wide first-aid meet was held under the joint auspices of the Kentucky Mining Institute, the American Red Cross and the United States Bureau of Mines. The events were interesting and some excellent work was done.

Mr. E. B. Sutton, of the United States Bureau of Mines, had charge of the actual contests. Much credit should be given to him and to those who assisted in the training of the teams and in making arrangements for the meet.

Possibly it might have been better to have allowed 3 days for the meeting as there was not sufficient time to satisfactorily visit any of the mining plants. When a meeting is confined to 2 days, it seems necessary to slight some part of it, and as there is no part which can be slighted without impairing the value of institute meetings, it would seem best to give a little more time so that there can be more papers and more discussions, more time to visit plants, and more time for the first-aid meet.

This was the first meeting of the Institute to be held in this district. The developments there are comparatively new and are growing

rapidly. It will be very interesting to see the expansion which the next few years are sure to bring. Kentucky has immense deposits of available coal and, if present conditions covering cost of production and transportation continue, she will soon rival West Virginia and even Pennsylvania in production.

Resignation of Dr. E. W. Parker

Dr. Edward W. Parker, statistician in charge of the division of Mineral Resources of the United States Geological Survey, and for many years Government coal statistician, has resigned his position to become the head of a Bureau of Statistics for the Anthracite Field. The object of this bureau is to extend the use of anthracite by such publications and literature as may be convincing of the benefits of anthracite as compared to other forms of fuel, and to cultivate a wider field for the use of anthracite by laying its advantages before fuel consumers. For the present Doctor Parker will be located in Wilkes-Barre.

In transmitting the resignation to Secretary Lane, Director George Otis Smith expressed his regret both personally and as a public official at "this termination of Mr. Parker's long and efficient service. As coal statistician of the Government since 1890 and as chief of the Division of Mineral Resources of the Geological Survey since 1908, Mr. Parker's contribution to the present standard of the annual report 'Mineral Resources' has been large and important. In the nature of public service should also be mentioned important work by Mr. Parker in studies of coal testing and conservation, and the publication by him in the engineering press of many papers on coal mining and production. From his own standpoint, however, Mr. Parker is to be congratulated in his new connection with the anthracite coal interests, where he will continue his activities along lines on which he has long been regarded as authority."

With Secretary Lane's approval, Director Smith has designated H. D. McCaskey as geologist in charge of the Division of Mineral Resources of the Survey to succeed Mr. Parker. Mr. McCaskey brings to his new position experience, not only as a geologist of the Geological Survey since 1907 and section chief since 1912, but also as a mining engineer in the Philippine Mining Bureau from 1900 to 1903, and as chief of that bureau from 1903 to 1906. Mr. McCaskey will also continue his work upon the metallic resources of the United States and Mr. C. E. Lesher has been designated to take up the coal work specialized on by Mr. Parker.

PERSONALS

At the recent annual meeting of the stockholders of the Pennsylvania Coal and Coke Corporation, held at Philadelphia, Mr. A. G. Edwards was elected a director to succeed Major Everett Warren, of Scranton, retired. All others of the old directors were reelected.

S. C. Thomson, late consulting mining engineer to S. Neumann & Co., and Mr. J. N. Bulkley, late consulting mechanical and electrical engineer to General Mining and Finance Corporation, Ltd., London and Johannesburg, have opened joint offices as consulting engineers, in the Equitable Building, 120 Broadway, New York.

George F. Keiser, formerly superintendent of the Pine Hill Coal Co., at Minersville, Pa., has purchased the Ellsworth colliery near St. Clair, Pa. The colliery was formerly owned by John Davis, Charles D. Norton, and others.

E. F. Saxman, former president of the Saxman Coal and Coke Co., W. Va., has been made vice-president and general superintendent of Ebensburg Coal Co., at Clover, Pa.

R. H. Buchanan, formerly engineer with Madeira-Hill & Co., is now superintendent of the Oak Hill Coal Co., near Minersville, Pa.

The University of Pittsburg's evening course in Principles of Coal Mining, at Irwin, Pa., conducted by Robert M. Black, Assistant Professor of Mining, closed on April 21. This course is the second year's work in the program of University Extension outlined by the School of Mines. Those who received certificates of proficiency were William H. Evans, Albert H. Jones, John W. Luteman, Joseph W. Rymer, and James N. Stein.

S. E. Van Horn, assistant chief engineer of the Delaware & Hudson Coal Co., has been promoted to the office of chief engineer. Mr. Van Horn's office will be at Scranton, Pa.

E. C. Lambert, state mine inspector of the Twelfth District of West Virginia, has resigned that position to go with the Excelsior Pocahontas Coal Co. at Excelsior, W. Va.

At the recent annual meeting of the stockholders of the Joseph Dixon Crucible Co., the present board of directors were reelected. The latter then reelected the present officials for another year.

O. L. Remington, general manager of William McLean & Co., Melbourne, Australia, is visiting this country and investigating American engineering methods, modern machinery, and methods of mining throughout the coal mining fields of the various states.

J. F. Healy has resigned his position as vice-president and general manager of the Consolidated Fuel Co., Black Hawk Coal Co., Castle Valley Coal Co., and Panther Coal Co., all of Salt Lake City, Utah. His duties will be assumed by President E. F. Carpenter, who will move from Salt Lake City to Hiawatha, Utah. Robert M. Magran has been appointed general superintendent of all these mines. It is believed that the injunction proceedings against the consolidation of the four companies will soon be dropped and the concerns united under one head.

Lubricating Oil Tests

Importance of the Viscosity Test in Determining the Use to Which an Oil is Suited

By R. C. Merchant*

Among the features very often discussed both by the buyer and seller of lubricating oils, and but slightly understood (if at all) by either of them, is the matter of physical tests. These cover gravity, flash, fire (or burn), cold test (divided into "pour chill" and "cloud"), and viscosity.

Gravity Test.—This test is commonly expressed in terms of Baumé or specific gravity scale, and in the United States indicates the relation in the weight of the oil to a corresponding volume of distilled water. If at a temperature other than 60° F. it is corrected to this standard temperature.

Flash and Fire Tests.—The initial flash test is the lowest temperature at which sufficient gas is driven off from the volume of the oil to cause a momentary firing from a small flame applied by the operator. The fire test is a completion of the operation with intervening flashes after the initial one, as the temperature rises, until the volume of oil takes fire and remains burning.

Cold Tests.—Information regarding this test is useful as indicating the temperature condition in which the oil may be used without congealing or solidifying. Tests in connection with this item of information are sometimes expressed as (1) "pour" test, which shows approximately the lowest temperature at which oil will just pour; and (2) "chill" or "cloud" test, which indicates the highest temperature at which a cloud first appears in transparent oil.

Viscosity Test.—The viscosity of an oil is an indication of what may be expressed as the fluidity, the body, or the cohesiveness of the molecular constituents of the oil. Crudely explaining the method of determining viscosity, we may say that it is represented by the number of seconds of time that a given quantity of oil at a given temperature requires to run through an aperture of given size. There are several makes of viscosimeters for this purpose, and each naturally has its corps of adherents and exponents, but undoubtedly the one or ones nearest the extreme of desirability should embody the greatest simplicity of operation, consistent with the possibility of duplicating its own tests. In most cases of external lubrication with oil, viscosity is possibly the most important consideration but, probably through lack of knowledge and information regarding this essential, it is seldom favored with even a thought by the immediate buyer or seller. While in such cases as involve any consideration of the physical characteristics at all, it is more frequently the case that much stress is laid on the gravity test and nearly as much on the fire test.

As the usual commercial practice in the petroleum business is to refer to gravities in terms Baumé, we use this means of identification more frequently than specific gravity.

As an indication of the lack of consistency applying to the relation of gravity to viscosity, and having in mind a more or less popular, but not necessarily correct, opinion that oils with heavier gravitation than others should possess higher viscosities, a few pertinent examples, Table 1, are cited. In the examples the gravities are in terms Baumé. The viscosity readings were determined on the Saybott Universal Viscosimeter.

Table I

Gravity Baumé	Viscosity, Seconds at 100° F.
25.0	183
26.5	100
27.1	665
27.7	460
28.0	285
28.1	62
28.5	235
29.5	200
30.0	184

From this tabulation it can readily be seen that if one has been securing an oil, let us assume of 28° gravity, it is not by any means safe to assume that the purchase of the oil of 25° gravity (greater weight) is an indication that he is receiving an oil of greater viscosity (more body). It is perhaps quite true, however, that if a given volume of crude oil were charged for distillation to be made into several different grades of oil, and the process of manufacture from inception to conclusion for the various different grades were all manipulated practically alike, the varying gravities of the final products would be a rough guide to their comparative viscosities.

If instead, however, a portion of crude oil reached a complete or finished state by one process of distillation, and the other portion by another method of distillation, we would then receive the apparent inconsistencies in gravity relations to viscosities as indicated by the tabulated statement. This assists the layman toward an inclination to believe the lubricant with the darker color has a higher viscosity than the lighter colored product, yet the following tabulation will show how absurdly erroneous this idea may be:

Gravity	Viscosity	Color
28.1	62 at 100°	Deep red
29.6	250 at 100°	Light amber

It might be well to mention the frequency with which the term heavy is incorrectly used, as intending to apply to other than the weight of the oil; correctly it may be associated with gravity, but when applied to viscosity it is very likely to be misleading, and we would suggest the terms viscosity or body or thickness.

In this immediate discussion we are treating the average general proposition of external engine and machinery lubrication, and will

(Continued on Page 625)

*Abstract from paper read before Chemical Society Northeastern Pennsylvania, April, 1915.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.
The editors are not responsible for views expressed by correspondents.

Ventilation and Mechanics

Editor The Colliery Engineer:

Sir:—Will you please solve the following questions:

1. If an airway is to be 6 feet high and to pass 10,000 cubic feet of air per minute at a velocity of 300 feet per minute, what must be its width?

2. If a piece of rock falling from the roof to the ground had attained a velocity of 1,200 feet per minute when it struck the floor with a force equal to 5,000 pounds, give weight of the rock, the time it was in falling, and the thickness of the seam.

Henry Hennessey
Uniontown, Pa.

Ques. 1 may be solved by a formula

$$q = a v$$

q = quantity of air, in cubic feet per minute;
a = cross-sectional area of airway;
v = velocity of air in feet per minute.

Substituting, $10{,}000 = 300\,A$.

Since the area equals the width multiplied by the height, and assuming W = the width, the area = $6\,W$.

Substituting again, $10{,}000 = 300 \times 6\,W = 1{,}800\,W$.

W = 5.56 feet, or the width of the airway

Ques. 2. The velocity = 1,200 feet per minute = 20 feet per second.

Velocity = $g\,t$;
g = acceleration (32.2 feet per second per second);
t = time in seconds.

Substituting, $20 = 32.2\,t$.

$t = .62$ second.

Let s = the distance the rock fell, and by the formula $s = \frac{1}{2}\,v\,t$ we have $s = \frac{20 \times .62}{2} = 6.2$ feet or the height of the seam.

The energy, or capacity of doing work, of a body at a given height and let fall, cannot be expressed in pounds, simply, but only in foot-pounds, which is the product of the weight of the body into the height through which it fell, or the product of its weight divided by 64.4 into the square of the velocity in feet per second which it acquires after having fallen the given distance.

Then: $\frac{5{,}000 \text{ foot-pounds}}{6.2 \text{ feet}} = 806$ pounds or the weight of the rock. This result can be corroborated by the second method, as follows:

$$\frac{Wt}{64.4} \times 20^2 = 5{,}000 \text{ foot-pounds.}$$

$$Wt = \frac{5{,}000 \times 64.4}{400} = 806 \text{ pounds.}$$

Burning Pulverized Coal

Editor The Colliery Engineer:

Sir:—I notice in the May issue of The Colliery Engineer you have an article on "The Burning of Pulverized Coal," by R. C. Carpenter and F. R. Low, read before the American Society of Mechanical Engineers at St. Paul, Minn., June, 1914.

You particularly speak of the work done by Hurry and Seaman, engineers of the Atlas Portland Cement Co. This is rather misleading as a man named Thomas R. Crampton got out a British patent No. 2,438 dated June 22, 1877, for the manufacture of Portland cement; it is fully described in this patent. He also got out a patent in this country February 7, 1871, patents Nos. 111,614 and 111,615 which patent the writer has made and used with very successful results in the burning of pulverized cement in the rotary kilns.

Also J. G. McAuley got out a patent No. 247,570 patented September 27, 1881. J. G. McCauley also got out patent No. 441,688 for the burning of pulverized fuel in the boilers, he also got out patent No. 441,689 dated December 2, 1890, which patent most cement companies in the United States are using today.

These are facts. Kindly give this space in your paper.

William H. Harding
Philadelphia, Pa.

Ventilation

Editor The Colliery Engineer:

Sir:—Will you please solve the following problem:

A body falling freely passes two points 1,000 feet apart in 2 seconds. What was its velocity when it passed the first point?

There has been a controversy over this question. One person says the velocity required is 467.8 feet per second, while another claims 451.7 feet per second to be correct.

Please enlighten me on this subject and oblige.

A. C. D. Altroy
Mountain Park, Alb.

The question may be solved very simply in the following manner:

Assume that the acceleration g = 32.2 feet per second per second.

Let V_1 = velocity at first point.
V_2 = velocity at second point.

Since the distance between the two points is 1,000 feet and the time taken to cover that distance was 2 seconds,

$$\frac{V_1 + V_2}{2} = \text{the average velocity;}$$

$$\frac{V_1 + V_2}{2} \times 2 \text{ seconds} = \text{distance;}$$

or $$\frac{V_1 + V_2}{2} \times 2 = 1{,}000;$$

$$V_1 + V_2 = 1{,}000 \text{ feet per second.}$$

Since acceleration g = 32.2 feet per second per second,

Then,

$$V_2 - V_1 = 2 \times 32.2 = 64.4 \text{ feet per second;}$$

or subtracting,

$$V_1+V_2=1{,}000.0$$
$$V_1+V_2=\quad 64.4$$
$$2\,V_1=\quad 935.6$$

$V_1=467.8$ feet per second, which is the velocity required.

Mine Management

Editor The Colliery Engineer:

Sir:—In your May number a correspondent asks for an answer to the question:

"State how you would develop, arrange, equip, officer, and manage a gaseous and dusty mine to insure freedom from accumulation of gas and dust and the danger incident thereto, keeping in view safety and economy?"

Lay the mine out in separate districts with an ample number of airways throughout. Carry the air about the mine in energetic quantities by well-built overcasts, stoppings, doors, regulators, brattices, etc.

Equip the mine with locked safety lamps, safety explosives, and shot firers. Keep the mine in good physical condition, drawing all pillars clean so as to have the overlying strata subside evenly over the worked-out areas. Employ an operating power consistent with the gaseous character of the mine. Install an ample ventilating plant of good design and an efficient watering system. Employ an ample number of mine officials, that the mine as a whole and in detail may be carefully and daily inspected. Cooperate with and instruct officials and workmen in their duty, and lay down rigid regulations for the guidance of officials and workmen and see that the regulations and provisions of the mine law are vigorously carried out.

This question was asked May 7, 1915, at the Pennsylvania Bituminous Mine Foreman's Examination. The answer given above is taken from the ones used by the examiners to correct the papers. It carried 10 per cent.

Hope it will please the one who asked for it.

Miner

Luzerne Mines, Pa.

Thirty-Three Years a Geologist

One of the most valued rewards of the scientist is the respect and good will of his coworkers; and, capitalized on this basis, Capt. Baird Halberstadt should regard himself as a millionaire.

There is seldom gathered together such a company as met in Pottsville, Pa., on April 24, on Captain Halberstadt's invitation to celebrate the thirty-third anniversary of his appointment to his first commission on the Second Geological Survey of Pennsylvania. Rear Admiral Robert E. Peary, the Actic explorer, was the guest of honor and there were geologists and other scientific and mining men from all parts of the country.

Capt. Baird Halberstadt

The Southern Anthracite Field, of which Pottsville is the center, has been the scene of much of Captain Halberstadt's labor, and the developments by the Philadelphia & Reading Coal and Iron Co. have uncovered many remarkable geological conditions there, and to show these to an interested and understanding audience, a trip was arranged by W. J. Richards, president and general manager of the P. & R. C. and I. Co., who has long been an intimate friend of Captain Halberstadt.

The guests were received informally at the Pottsville Club on the evening before, and early in the morning of the 24th were taken in automobiles to view the various operations nearby. At Bear Run stripping they saw the coal seams uncovered and mined by daylight. At Suffolk they were entertained by a demonstration given by one of the Reading first-aid corps; at Maple Hill colliery some of the party went into the mine and after they came out a lunch was served. Next they visited the Ellangowan stripping, Shenandoah, Ashland, Heckscherville Valley, and Pine Knot colliery, returning to Pottsville by way of Cressona.

In the evening, at the Pottsville Club, a dinner was given by Captain Halberstadt, at which were present an assemblage of men of note in the scientific and mining world such as could be gathered only by a man esteemed for his personal qualifications and honored for his abilities in his profession. The dinner was a happy occasion, at which the time flew quickly with speeches and humor and the celebration, as a whole, was an event that will be long remembered both by Captain Halberstadt and his friends.

Congratulatory telegrams or letters of regret were received from General A. W. Greeley, the Arctic explorer; Robert A. Quin, manager of the Susquehanna Coal Co.; Rufus J. Foster, managing editor of The Colliery Engineer; Doctor Hovey, a distinguished geologist who cabled from the Island of Barbadoes; and Edward Hull, LL. D., F. R. S., F. G. S., etc., formerly Director of Imperial Geological Survey of Ireland and Professor of Royal College of Science in Dublin.

The following is a list of those who were present:

Rear Admiral Robert E. Peary, U. S. N. George Otis Smith, Ph. D., Director, U. S. Geological Survey. Marius R. Campbell, Coal Geologist, U. S. Geological Survey. Prof. Frank Knowlton, Paleontologist, U. S. Geological Survey and Curator, U. S. National Museum. Prof. George H. Ashley, Administrative Geologist, U. S. Geological Survey and former State Geologist of Tennessee. Dr. Alfred H. Brooks, U. S. Geological Survey and Geologist in Charge Division Alaskan Mineral Resources. Dr. W. C. Mendenhall,

U. S. Geological Survey. Frank Sutton, Geographer, U. S. Geological Survey. Edw. W. Parker, Statistician, Chief of Division of Mineral Resources, U. S. Geological Survey. Charles Enzian, U. S. Bureau of Mines, Wilkes-Barre. Prof. Henry Kummel, State Geologist, of New Jersey. Prof. Thomas L. Watson, Professor of Geology, University of Virginia and State Geologist, of Virginia. Dr. I. C. White, State Geologist, West Virginia. Dr. Edw. B. Mathews, Assistant State Geologist of Maryland. Prof. Frank De Wolf, Director, Geological Survey of Illinois. Prof. H. A. Buehler, Bureau of Geology and Mines, Missouri. Prof. W. O. Hotchkiss, State Geologist of Wisconsin. Prof. R. C. Allen, State Geologist of Michigan. Dr. H. L. Fairchild, Professor of Geology, University of Rochester. Dr. Gilbert Van Ingen, Professor of Geology, Princeton University. Dr. Charles E. Munroe, Professor of Chemistry, George Washington University. Prof. George W. Littlehales, Hydrographic Engineer, U. S. N., and Professor of Nautical Science, George Washington University. Dr. W. R. Crane, Professor of Mining Engineering, Pennsylvania State College. Dr. Frederick B. Peck, Professor of Geology, Lafayette College. Prof. Andrew S. McCreath, Industrial Chemist and Commissioner, Topographic and Geologic Survey of Pennsylvania. Prof. Bailey Willis, Geologist, Washington. Capt. A. F. Lucas, Mining Engineering, Washington. Frank L. Hess, Mineralogist, U. S. Geological Survey. Floyd W. Parsons, Editor in Chief, *Coal Age,* New York. Frederick W. Saward, Editor and General Manager, *Coal Trade Journal.* W. J. Richards, President and General Manager Philadelphia & Reading Coal and Iron Co. S. D. Warriner, President Lehigh Coal and Navigation Co. Edwin Ludlow, Vice-President Lehigh Coal and Navigation Co. W. C. Whildin, Mine Superintendent Lehigh Coal and Navigation Co. Thomas Fisher, General Manager Berwind-White Coal Mining Co. Morris Williams, President Susquehanna Coal Co. Robt. A. Quin, Manager Susquehanna Coal Co. Frank A. Hill, General Manager Madeira-Hill Coal Mining Co. John J. Tierney, Vice-President and General Manager Crozer-Pocahontas Co. E. A. Delaney, Chief Engineer, Berwind-White Coal Mining Co. George M. Keiser, General Manager Pine Hill Coal Co. Jas. B. Neale, President Buck Run Coal Co. Wm. Auman, Superintendent Susquehanna Coal Co., Lykens Division. D. V. Randall, Superintendent Susquehanna Coal Co., Lytle Division. V. Corde Snyder, Superintendent Lehigh Valley Coal Co., Snow Shoe Division. W. R. Reinhardt,, Superintendent Susquehanna Coal Co., Shamokin Division. Reese Tasker, Mining Superintendent P. & R. C. and I. Co. George S. Clemens, Mining Engineer P. & R. C. and I. Co. Claude F. Lewis, Division Superintendent P. & R. C. and I. Co. Wm. P. Smythe, General Superintendent St. Clair Coal Co. Jos. H. Garner, Division Engineer P. & R. C. and I. Co. John F. Bevan, Mining Engineer, P. & R. C. and I. Co. E. E. Kaercher, General Superintendent P. & R. C. and I. Co. George B. Hadesty, General Superintendent P. & R. C. and I. Co. John H. Pollard, Division Superintendent P. & R. C. and I. Co. J. P. Jones, Paymaster P. & R. C. and I. Co. John Wood, Superintendent of Shops, P. & R. C. and I. Co. Francis Critz, Assistant Superintendent Shops P. & R. C. and I. Co. A. G. Blakeley, Chemist P. &. R. C. and I. Co. W. H. Lesser, Mechanical Engineer P. & R. C. and I. Co. J. P. Jennings, Electrical Engineer P. & R. C. and I. Co. James Morris, Secretary to President P. & R. C. and I. Co. J. E. Turk, Superintendent Shamokin Division, P. & R. C. and I. Co. R. H. Buchanon, Superintendent Oak Hill Coal Co. A. E. Lehman, Mining Engineer and Topographical Geologist, Philadelphia. Edwin M. Chance, Consulting Chemist, Wilkes-Barre. Horatio Morris, Superintendent Madeira-Hill Coal Mining Co. Edwin C. Luther, Engineer, Sheafer Estate. Arthur W. Sheafer, Mining Engineer and Geologist. Wm. A. Cochran, Civil and Mining Engineer. Wm. S. Pugh, Civil and Mining Engineer, City Engineer of Pottsville. Chas. W. Wagner, Division Engineer Northern New York Development Co. Edw. Brennan, President and General Manager, Greenough Coal Co. Hon. James E. Roderick, Chief of Department of Mines of Pennsylvania. M. J. Brennan, State Mine Inspector. John Curran, State Mine Inspector. Herbert Kynor, Engineer, Lehigh Coal and Navigation Co. Hon. MacHenry Wilhelm, Judge of Orphans' Court. Hon. R. H. Koch, Additional Law Judge, Schuylkill County. Hon. Chas. N. Brumm, Additional Law Judge, Schuylkill County. Wm. S. Leib, General Manager Schuylkill Electric Railway. Wm. B. Rockwell, General Manager Eastern Pennsylvania Railways. E. L. Herndon, Treasurer Eastern Steel Co. Robert Allison, Mechanical Engineer (retired), Port Carbon. W. H. Stout, Agricultural Geologist, State Board of Agriculture. Wm. H. Lewis, Coal Operator (retired). Harry Hunter, Ashland. Col. James Archbald, Engineer Girard Estate. Hon. F. Pierce Mortimer, Mayor of Pottsville. Hugh Dolan, City Commissioner. Hon. A. L. Shay, former Additional Law Judge, Schuylkill County. J. S. Ulmer, President Miners' National Bank. C. T. Brown, Cashier Pennsylvania National Bank. J. W. Fox, Secretary and Treasurer, Safe Deposit Bank. B. J. Smith, County Commissioner. C. T. Mould, Architect. Dr. J. B. Rogers, President Board of Health. Dr. L. T. Kennedy. Dr. W. C. Bowers, Superintendent Insane Hospital. C. W. Unger, Paleontologist. Dr. H. J. Herbein, Secretary Board of Health. James R. Williams, Galena Signal Oil Co. Frank Muehlhof. Capt. C. M. Wilhelm, Troop C, State Police Force. Capt. S. B. Edwards. J. J. McKnight, Superintendent Pottsville Gas Co. Rev. Dr. James F. Powers. D. W. Kaercher, Esq., Solicitor Girard Estate. Geo. M. Roads, Esq., Solicitor L. C. and N. Co. Dr. G. H. Halberstadt, Surgeon P. & R. C. and I. Co. First-Aid Corps. Mr. G. A. Muehlhof, P. & R. C. and I. Co. Dr. A. L. Gillars. Hon. James B. Reilly. W. G. Gregory, Land Agent, Estate of P. W. Sheafer (deceased). B. S. Simonds, Probation Officer. H. I. Silliman, Editor *Pottsville Journal.* A. H. Roehrig, *Pottsville Journal.* R. C. Shearer, *Evening Chronicle.* A. H. Tiley, *Ashland Telegram.* George H. Steidel, Borough Engineer of Minersville. Hon. C. A. Snyder. Capt. Harry Chambers, U. S. N. Hon. R. D. Heaton. Daniel Duffy, Member City Planning Commission. T. B. Van Buren, Division Engineer P. & R. C. and I. Co. George D. Evans, Mining Engineer. Wm. Wells, Engineer, Pine Hill Coal Co.

BOOK REVIEW

A review of the latest books on Mining and related subjects

The Mining World Index of Current Literature Volume 6, covering the last half of the year 1914. By George E. Sisley, associate editor of the *Mining and Engineering World.* The Mining World Co., Monadnock Block, Chicago, 200 pages. Like its predecessors of the series, this volume contains references to practically all articles dealing with the subjects of mining, engineering, metallurgy, mining geology, mineralogy, etc., which have appeared anywhere in the world during the period covered. In this volume nearly all of the entries contain brief digests of the articles treated. This greatly increases the value of the book.

Houses in Mining Towns. Bulletin 87, by J. H. White, 60 pages, illustrated. Issued by United States Bureau of Mines.

Few publications have been issued that are more interesting than this one recently distributed by the Bureau discussing mining towns.

Not only are town sites, street systems, construction of sidewalks and gutters, alleys, etc., discussed, but also the different types of houses, materials for construction, advantage of frame houses, etc. Considerable attention is paid to the lighting of houses, position and spacing of windows, doors, and artificial illumination. Sanitation is a special feature of the bulletin, as every detail is covered in a thorough manner.

Lastly, detailed plans of various cottages are given. Many of the suggestions contained in the bulletin are incorporated into these tracings, special features being: substantial, well-constructed foundation walls; double flooring lined with paper; large window area with weighted sashes; usefully located electric lights; etc.

Exhaust Steam Turbines

Written for The Colliery Engineer

Steam turbines are being quite largely introduced in the mining field and sometimes result in considerable economies. This is quite noticeable in the case of low-pressure turbines, which take their steam from the exhaust of some non-condensing engine or pump. Any steam engine is a heat engine. The ordinary engine takes its steam at, say, 100 pounds pressure and exhausts it at atmospheric pressure, that is, 14.7 pounds per square inch. The temperature of this exhaust steam is then approximately 212° F. and each pound of steam contains about 751,000 foot-pounds which is entirely lost. By passing steam into a condenser, its temperature is reduced to nearly that of the atmosphere and its pressure to a point approaching absolute zero, more or less nearly, according to the operation of the condensing plant. Since it requires less power to operate the condenser than is lost in exhausting the steam at atmospheric pressure, work is saved.

It is, of course, true that this work can be saved by condensing the steam, no matter whether a reciprocating engine or turbine is used, but there are many cases where engines are being used which are running non-condensing, where a low-pressure turbine can be conveniently installed. Such additional equipment results in saving a large part of the energy of the exhaust steam which passes through the turbine. The expense involved consists of the capital invested, the cost of repairs and depreciation, and cost of pumping water for the condenser.

Two installations of this type will illustrate the possibilities. At the Penn Gas Coal Co.'s mine No. 2, at Irwin, Pa., a 200-kilowatt Kerr turbine has been installed. This runs at 3,600 r. p. m. and is geared to a Crocker-Wheeler direct-current generator running at 900 r. p. m. and delivering 364 amperes at 550 volts. The back pressure of the steam at the turbine is 3 pounds per square inch and the vacuum at the turbine is 26 inches. Live steam is automatically admitted to the turbine when the load is above 350 amperes. A turbine of this type and size running at full load of 200 kilowatts with 2-pound pressure and 26-inch vacuum takes about 38 pounds of steam per kilowatt hour. The steam goes from the turbine to a Wheeler surface condenser which takes water from the mine pump at the bottom of 200-foot shaft. The condenser is designed to use 700 gallons per minute at full load, assuming the temperature of the water to be 70° F.

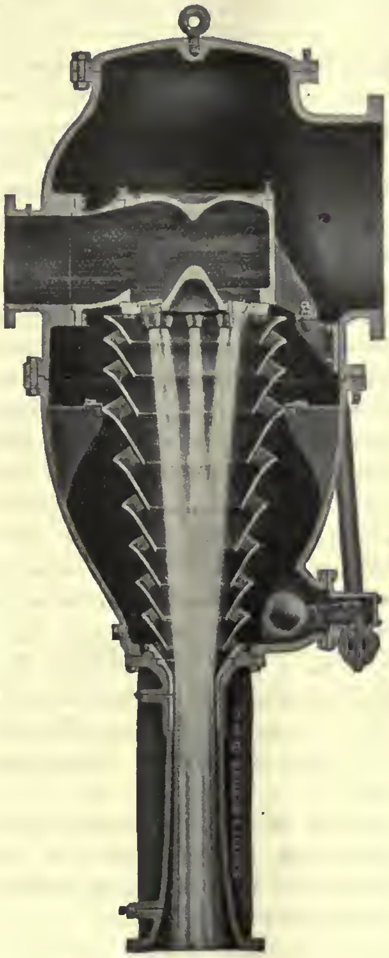


Fig. 1. Eductor Condenser

It is apparent that one of the possibilities for economy in this case is the fact that the water has to be pumped out of the mine anyway and its delivery to the condenser is simply a matter of pipe connection so that it is unnecessary to charge the circulation of water to the turbine. A small vacuum pump is operated in connection with the condenser. A further favorable fact is that the mine water is not corrosive but is good enough for boiler purposes. The condenser has been examined several times since its installation and no damage is apparent.

Fig. 2. Kerr Turbine-Generator Set

This installation supplies current to four haulage locomotives which replace compressed-air locomotives. This has permitted shutting down two large locomotive charging compressors which consume about 300 h. p. each. One 300-h. p. boiler has been shut down and the load on the other boilers has been decreased.

The Westmoreland Coal Co. is using similar equipment at a mine at Irwin. Here electric haulage has replaced endless rope. Two compressors have been shut down, with two 150-h. p. boilers and one smaller boiler.

The principal interest at this plant is in the fact that a very corrosive mine water is used in the condenser. The water is so bad that the pumps and pipes are wood lined. The main pumps discharge through a cement-lined bore hole and in this case, as in that previously mentioned, the water has to be pumped from the mine anyway. In this case, however, in order to obtain the necessary head for operating the condenser the water is pumped into a small standpipe, made from two old Cornish pump barrels so placed as to give a head of 21 feet at the condenser, with a pressure of 9 pounds, which is sufficient for the purpose. This water is raised from a depth of 180 feet by a pump having a capacity of 850 gallons per minute. The condenser used is a Schutte & Koerting Eductor, Fig. 1, in which jets of water issuing through small nozzles at a velocity due to the pressure of 9 pounds per square inch entrain the steam coming from the turbine. No vacuum pump is necessary. The

water is discharged into a well, the pipe dipping below the water and forming a water seal. Water flowing from this well passes the boilers where it washes away the ashes. The condenser gives a vacuum of about 26 inches. The nozzles on the condenser are practically the only part affected by the acid water and these last about 2 months. The cost is $36 per set.

In this plant, steam is taken from the exhaust through a T, but as no valve is used there is no back pressure and no pressure on the turbine.

The cost of a complete turbine installation of the type mentioned is about $45 per kilowatt for the 200-kilowatt size, $40 per kilowatt for the 300-kilowatt size, and $35 per kilowatt for the 500-kilowatt size.

In each of these cases, it may be emphasized that exhaust steam is used and that the work done by this steam is a direct saving. The cost of the turbines and the generators would be practically the same if high-pressure steam were used. In each case the water has to be pumped from the mine. Practically the only difference between the two installations is in the condensers and in both cases the operation of these is very inexpensive so that the work done by this steam by virtue of its more complete cooling is very largely saved.

The information given above was obtained through the courtesy of Mr. A. P. Cameron, general superintendent of the Westmoreland Coal Co., and Mr. K. Witmer, master mechanic of the same company.

Rhode Island Anthracite

Rhode Island anthracite has long been a puzzle to mining men and capitalists. Is it a fuel or can it be best used for making refractory linings for blast furnaces? After a study of the Rhode Island anthracite field, the character and qualities of the coal, and the results of tests of its use in house and steam furnaces and in the making of briquets and coke, the United States Geological Survey has published a preliminary report by George H. Ashley in Bulletin 541-F.

The coal has been known in Rhode Island for 150 years or more and during the last 100 years scores of attempts have been made to mine it commercially in many places. With one exception these attempts have not been successful, and most of the mines have been abandoned within 3 years.

In general it has been found that Rhode Island anthracite is difficult to handle, and that the cost of handling, on account of the large quantity required to produce a given amount of heat and the higher percentage of ash, will be greater than that of other coals; furthermore, when burned it can produce only from 40 to 80 per cent. of the heat units produced by the coals with which it necessarily must compete. In general it may be said to show about two-thirds the heat value of Pocahontas coal and when the extra cost of handling the coal and ash is reckoned it may be estimated that Rhode Island anthracite will yield not over one-half the heat afforded, dollar for dollar, by Pocahontas coal.

A copy of the bulletin may be obtained free on application to the Director of the Geological Survey, Washington, D. C.

OBITUARY

FRED. C. KEIGHLEY

Frederick Charles Keighley, 60 years old, general superintendent of the coke plants of the Oliver-Snyder Steel Co., committed suicide on the morning of April 14. Mr. Keighley, it is believed, was driven to suicide as a result of worry over financial matters.

He was born at Victoria Terrace, Keathley, Yorkshire, May 5, 1855, and was educated in the English schools until his parents came to America and located at Youngstown, Ohio, where he completed his education. He took up the study of mining engineering, and in 1876 became superintendent of the mines of the Mahoning Coal Co.

In 1881 Mr. Keighley was made superintendent of the Youngstown Coke Co. and soon afterwards went into the coal business for himself at Toms River, Pa., returning almost 2 years later to the superintendency of the Youngstown works. Later he become superintendent for the H. C. Frick Coke Co., at Mammoth, resigning in 1891, to become identified with the Oliver-Snyder Steel Co. interests. He assisted in the erection of the Oliver coke plant and in 1899 was made general superintendent of the three plants of the company.

His untimely death shocked his many friends. None of them can realize that he who faced so many perils in his mining career would give way to financial trouble. The Coal Mining Institute of America, of which he was a founder and a most active member, will miss him. Many of its members will recollect that he was ever ready to help with suggestions from his long and varied experience in coal mining and coke making, and will hold him in grateful remembrance.

JOHN E. CURRAN

John E. Curran, state mine inspector of the 18th District of Pennsylvania, died on May 1, at his home in Pottsville, Pa.

Mr. Curran was a native of Coal Castle, where early in life he entered the mines and by close application rose to the position of state mine inspector.

When a young man he became mine foreman in one of the mines in Heckscherville Valley, under the Philadelphia & Reading Coal and Iron Co. He was then transferred to the Otto colliery of the same company as general mine foreman and later to the Eagle colliery of the same company.

In 1903 he was elected state mine inspector, being among the first mine inspectors to take office under the elective system.

Mr. Curran's term would have expired on December 31, 1915.

Answers to Examination Questions

Questions Selected From Those Asked at Examinations for Mine Foreman and Fire Boss in Various States in 1914

Ques. 1.—If you had charge of a mine and the fan engine suddenly broke down, what would you expect to be the condition of the ventilation? How would you continue to run the mine the rest of the day?

Ans.—The condition of the air would depend upon the kind and amount of gases given off by the coal and whether the mine was laid out in such a way that natural ventilation might, in part, do the work of the fan. If there was considerable difference between the mine and outside temperatures, it is possible that a fairly strong natural current of air might be set up, the direction of its flow being determined by the difference in depth of the shafts, whether the mine or the outside temperature was the higher, etc. If there was no natural ventilation there would, in any case, be a gradual rise in the temperature of the mine air, due to radiation of heat from the ribs, roof, and floor. If the fan was of the blower type the reduction of pressure, due to its shutting down, might release more or less gas from the gob. As even so-called non-gaseous mines generate a little methane, gas might be detected in the workings, even if (when the fan was running) none had been found before. If the mine was ordinarily gaseous it might require but a few hours for the atmosphere to become highly explosive.

In answer to the second part of the question; no mine should be run when the fan is shut down or the ventilation stopped from any cause.

Ques. 2*.—In a mine where the coal is 6 feet thick, the old workings cover 20 acres, of which 40 per cent. are pillars; if the barometer drops from 30 to 29.5 inches, what volume of air will be released from the old into the new workings?

Ans.—As 60 per cent. of the coal has been removed from the old workings, the total volume of air in them is

$$43,560 \times 20 \times 6 \times .60 = 3,136,300 \text{ cubic feet.}$$

The volume of this air, when the pressure drops from 30 to 29.5 inches, will increase to $3,136,3000 \times \frac{30}{29.5} = 3,189,700$ cubic feet, about.

The volume of air released into the new workings will be $3,189,700 - 3,136,300 = 53,400$ cubic feet.

Ques. 3*.—Referring to the preceding question: If the air released from the old workings contains 5 per cent. of gas, and if the fall of the barometer is regular so that it takes 5 hours for this mixed volume of air and gas to escape, how many cubic feet of methane will be added to the air-current per minute; what must be the volume of the air-current in order that the amount of methane in it does not exceed three-tenths of 1 per cent.; and what will be the velocity of the air in the return which has a cross-section of 6 ft. × 10 ft.?

Ans.—The volume of mixed gas and air released per minute will be $53,400 \div (5 \times 60) = 178$ cubic feet. Since this contains 5 per cent. of gas, the total quantity of methane set free will be $178 \times .05 = 8.9$ cubic feet per minute.

That 8.9 cubic feet of gas may constitute but .3 per cent. of the air-current, the volume of the latter must be $8.9 \div .003 = 2,967$ cubic feet.

In the return, the velocity of the air would be $2,967 \div (6 \times 10) = 49.5$, say, 50 feet, per minute.

Ques. 4.—If the ventilation in a mine is insufficient, how may it be increased without increasing the power?

Ans.—The amount of air may be increased by reducing the resistance by cleaning up the airways and so enlarging them. This is particularly applicable to return airways which, as they are rarely visited, are too commonly clogged by falls of slate. In some cases, entries may be straightened so that the air will have a less distance to travel, and bends may be rounded to reduce the friction. To increase the quantity of air reaching the face, brattices should be overhauled and made tight to prevent leakage. In addition to the foregoing, the current should be divided into a series of splits instead of being conducted in a continuous current through the workings. By dividing the mine into a number of districts, each with its own separate air-current, the quantity of air circulated for the same power will be greatly increased.

Ques. 5.—If in making your examinations of an entry that has 36 working places, you discover that 28 of these places contain a large amount of gas, where would you place the warning board?

Ans.—In a case like this, the danger board should be placed at the mouth of the entry, and not a board at the mouth of each room. If the presence of dangerous amounts of gas in so many places is unusual, it might be well to place the danger board at the mouth of the mine, so

(Continued on Page 630)

*These questions are modified to make them of more general interest.

NEW MINING MACHINERY

Automatic Section Insulator

The Westinghouse automatic insulator, Fig. 1, recently patented, can be inserted in trolley wires where it is desirable to energize a section when the trolley passes on to it and to deenergize it when the trolley passes off. It promotes safety in mine installations where a branch is to be energized only when the locomotive is on that branch. Leakage losses and dangers of contact by persons passing under the trolley wire are thereby averted when the locomotive is not on the branch.

Fig. 1. Westinghouse Section Insulator

The circuit is opened and closed by a switch blade mounted on a rocker that the trolley operates. In one position the blade connects with copper contactors. In the other there is no connection. There is no arcing at the switch contact, because the rocker is always energized and the switch connection is always opened or closed while the trolley wheel is on the rocker.

The Clinton Latch

Frequent mishaps at mine switches have led the Clinton Switch Co. to produce a latch that is simple and yet effective when safety is considered.

It consists of three distinct parts: the latch, the base plate, and the bridle lug. The construction of the base plate makes the alinement of the latch and the rail correct at all times, and the only chance for the switch point to turn would be for the entire rail to turn with it. A flat rounded base, or pivot lug, on the butt end of the latch, fits into and interlocks with the base plate. The base plate is undercut on the bottom to fit over the base of a standard rail and slotted to receive the web. This allows all necessary motion of the switch-points but makes imperfect alinement impossible.

Its first cost is less than that of other types. The upkeep is negligible, in fact, nothing at all. There are no bolts, rivets, or strap irons to shear or to install and to wear out under hard usage.

Condit "I" Oil Starter

The demand for a fused oil switch for use in starting small induction motors which are thrown directly on the line, without the use of a starting compensator, is met by the Condit Electrical Mfg. Co.'s type "I" oil starter.

It is designed for motors whose normal running current does not exceed 30 amperes at 600 volts or less.

Because of the heavy starting current taken by induction motors which are thrown directly on the line, it has been customary to use fuses whose capacity was far in excess of the normal running current, and thereby the motor was afforded no overload protection under running conditions. This is one great objection to the ordinary open or enclosed, fused, air-break switch used for starting small motors of this type.

The use of this type of starter permits the motor to be fused for proper overload protection without blowing the fuses on starting the motor, and at the same time affords ample protection during the starting period.

The Lunkenheimer Exhibit

At the San Diego Exposition the Lunkenheimer Company are exhibiting their entire line of valves of all descriptions, water columns, and gauges, whistles, injectors, ejectors, bronze fittings, oiling devices, grease cups, and the like, in great variety.

The exhibit is neat and attractive, and the strength, durability and workmanship of Lunkenheimer products is self-evident.

Fig. 2. Lunkenheimer Exhibit at San Diego Exposition

Portable Electric Drills

The Western Electric Co. in its new Temco line has designed an electric portable drill to give long

service under severe conditions and hard usage. The drill is compact in design and light in weight. The weight is evenly balanced, making handling easy. An electric switch is conveniently placed near the handle, by which the motor may be reversed when the drill sticks. Whether working at high or low speeds, a touch of the switch reverses the motor, loosening the drill or sending it ahead as required.

Such drills are indispensable where holes are to be drilled or tapped and the material cannot be taken to a drill press. The motors are built to operate with either direct or alternating currents, at standard voltages. They are of the high-speed commutator type having forged nickel-steel shafts and built-up cores of magnetic steel.

The commutator consists of highly conducting hard drawn copper bars of ample carrying capacity forced together under high pressure and insulated by mica.

The drill appeals to the user on account of its portability, lightness

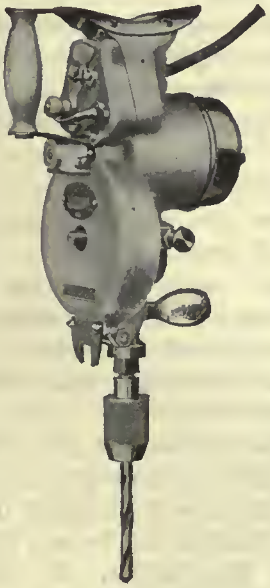


Fig. 3. Electric Drill

in weight, and application in many lines of mining work.

Phillips Screen Bar

For many years, the screen bar having the largest section, in general use was the Diamond top bar, which is $2\frac{1}{4}$ inches deep. While there were some inquiries for larger bars the demand was not great enough to justify the production of a larger section, and manufacturers and operators had to build up bars to suit their requirements at considerable expense. However, keen competition in the coal industry has necessitated more careful preparation of coal, especially in the larger sizes. This has resulted in a widespread demand for a larger screen bar. The Phillips Mine and Mill Supply Co. has designed such a bar, 4 inches deep, 1 inch wide across the top and $\frac{5}{16}$ inch thick at the bottom. It weighs 7.55 pounds per foot and

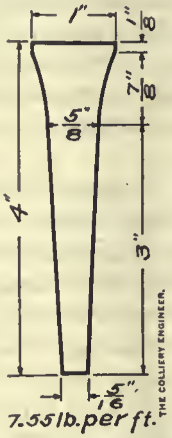


Fig. 4

is made in lengths up to 18 feet 6 inches; see Fig. 4.

It is an ideal bar for screens with wide spaces, as the depth of 4 inches allows enough of the bars to extend above the top of the bearers or supporting rods so that the corners of large lumps will not catch at the bearers and clog the screen; in fact a spacing of 6 inches can be safely accommodated without having to make provision for additional clearance in the bearers.

When the notches in the bearing bars are spaced at 1-inch centers, the width of 1 inch across the top of the screen bar makes it possible to vary the spacing of the screen by inches. The new bar is interchangeable with the Diamond bar and can be placed in the same notches, as its shank has the same taper and the same thickness at the bottom as the Diamond bar. The heavy shank and the shape of the head of the new bar insure stiffness and rigidity, while the curvature from the head to the shank will enable the screenings to

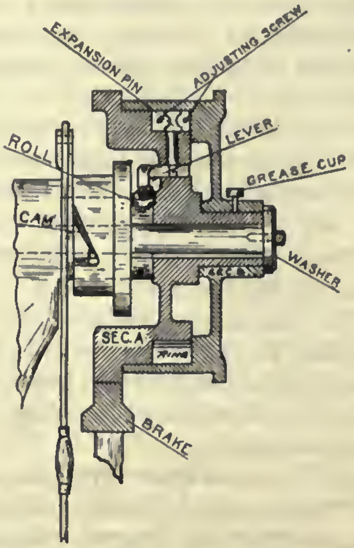


Fig. 5. Friction Clutch for Power Hammer

get away quickly and not wedge between the bars.

Friction Clutch on Power Hammer

The frequent isolation of blacksmith shops and the objection to overhead shafting has led to the adoption of motor-driven power hammers.

To successfully obtain this drive, Beaudry & Co. have designed a friction clutch, Fig. 5, which is simple in its design. It consists of 8 separate parts, viz.: pulley, ring, brake section, cam, lever, roll, expansion pin, and a washer.

The pulley runs loosely on the brake hub and is lubricated by means of a grease cup. When working, the operator has the hammer under perfect control according to the pressure he exerts on the treadle. The brake is automatically released when the hammer is in motion.

TRADE NOTICES

The Jeffrey Mfg. Co. announce the removal of their New York branch office from 77 Warren Street to 50 Dey Street. Mr. George H. Mueller is the manager in charge of this office.

The R. D. Nuttall Co., of Pittsburg, Pa., announce that the agency of their products in the Chicago territory has been transferred to the Westinghouse Electric and Mfg. Co., 39 S. LaSalle Street, Chicago, Ill.

The Western Electric Co., in Kansas City, have moved into their new distributing house at 608-610 Wyandotte Street opposite the old building which served as their headquarters for the last 10 years.

The Maryland Coal Co., of St. Michael, Pa., has placed an order for two 150-foot longwall coal conveyers with the Link-Belt Company, of Philadelphia, Pa.

The Wilson-Snyder Mfg. Co. and the Wilson-Snyder Centrifugal Pump Co., of Pittsburg, Pa., have opened a branch office at 52 Vanderbilt Avenue, New York City, in charge of Mr. A. H. Sherwood.

An Interesting Exhibit.—At the Panama-Pacific Exhibition a joint exhibit of the American Coal Products Co. and Barrett Mfg. Co. is extremely interesting. A large block of soft coal is displayed and with it are shown the crude ammonia, crude coal tar, benzol, etc., which are obtained in the by-product coking process. In connection with the crude ammonia are shown the products of further refinement. One case on exhibition by the Barrett Mfg. Co. shows how the life of timber, exposed to water, may be prolonged by the proper treatment with creosote oil. The longevity of the wood is apparent. Specimens are shown presenting a striking contrast between treated and untreated wood when subjected to the same conditions.

Ridgway Dynamo and Engine Co., of Ridgway, Pa., has closed a contract with the Vinton Colliery Co., Vintondale, Pa., for two 26″ × 28″ four-valve engines rated at 600 horsepower each, but which will at times be called on to deliver 900 horsepower each for 2 hours.

The W. H. Nicholson Co., of Wilkes-Barre, Pa., has appointed Stephen H. Meem & Co., of Bluefield, W. Va., as exclusive agents for "Wyoming" automatic eliminators, steam separators, and steam traps, in the southern portion of West Virginia, western Virginia, and eastern Kentucky.

Goodman Mfg. Co.—In the May issue, it was stated that the Goodman Mfg. Co. had presented one of their latest model electric shortwall coal mining machines to the Department of Mining Engineering of the University of Illinois, for testing purposes. It should have read loaned instead of "presented."

Catalogs Received

Richardson-Phoenix Co., Milwaukee, Wis. Peterson Power Plant Oil Filter and Accessory Apparatus for Central Oiling Systems, 32 pages.

Hooven, Owens, Rentschler Co., Hamilton, Ohio. Series E Heavy Duty Hamilton Corliss Engine Releasing Valve Gear, 14 pages.

B. F. Sturtevant Co., Boston, Mass. The Fan that Won the Suit. Circular.

Easton Car and Construction Co., Easton, Pa. Catalog of Railway Equipment, 52 pages.

International Mill and Timber Co., Bay City, Mich. The Famous Fifty Sterling System-Built Homes, 72 pages.

McDonough Automatic Regulator Co., Detroit, Mich. World's Best Feedwater Regulator, 12 pages.

Epping-Carpenter Pump Co., Pittsburg, Pa. Bulletin No. 102, Piston Pattern Pumps. Bulletin No. 104, End-Packed Pot Valve Pumps. Bulletin No. 103, Center-Packed Plunger Pumps. Bulletin No. 109, Centrifugal Pumps.

Myers-Whaley Co., Knoxville, Tenn. Shoveling Machines, 28 pages.

Clinton Switch Co., Clinton, Ind. The Clinton Latch, circular.

Kerr Turbine Co., Wellsville, N. Y. Economy Turbo-Pumps, 22 pages.

Jeffrey Mfg. Co., Columbus, Ohio. Single-Roll Coal Crusher, 31 pages.

Heating Value of Illinois Coals

Mr. J. M. Goldman, author of the article "Heating Value of Illinois Coals," an abstract of which appeared on page 494 of the April issue of The Colliery Engineer, writes that the Commonwealth Edison Co. is not responsible for the formula he devised. The formula referred to, gave the comparative heating value or number of B. T. U. offered for $.01 at point of use.

The complete formula includes factors pertaining to barge service which is common along river mines and is expressed:

$$V = \frac{TU}{p - \left[\frac{(A-G)p}{E}\right] + b + rm}$$

V = comparative heating value of number of B. T. U. offered for $.01 at point of use;

T = pounds per ton (2,000 pounds);

U = B. T. U. per pound, limiting minimum guaranteed by bidder;

p = price per ton expressed in cents;

A = maximum allowable percentage of ash;

G = percentage of ash, limiting maximum guaranteed by bidder;

E = percentage of ash at which value of coal as fuel disappears = 40 per cent.

Fixed charges:

b = rate per ton for barge service = 20 cents;

r = rate per ton-mile for barge towage—¼ cent downstream and ½ cent upstream;

m = miles of barge towage to point of delivery.

When the method of delivery is by cars, the factors b, r, and m are omitted. It will be noted that the above formula was devised for comparing bids, and all the variables —ash, the calorific value and price per ton—should be merged into one figure, the number of B. T. U. furnished for 1 cent. Accordingly, this formula has been devised in which the inverse ratio between the ash and the calorific value has been maintained and reflected in the cost of heating value for a standard commercial unit.

Lubricating Oil Tests

(Continued from Page 615)

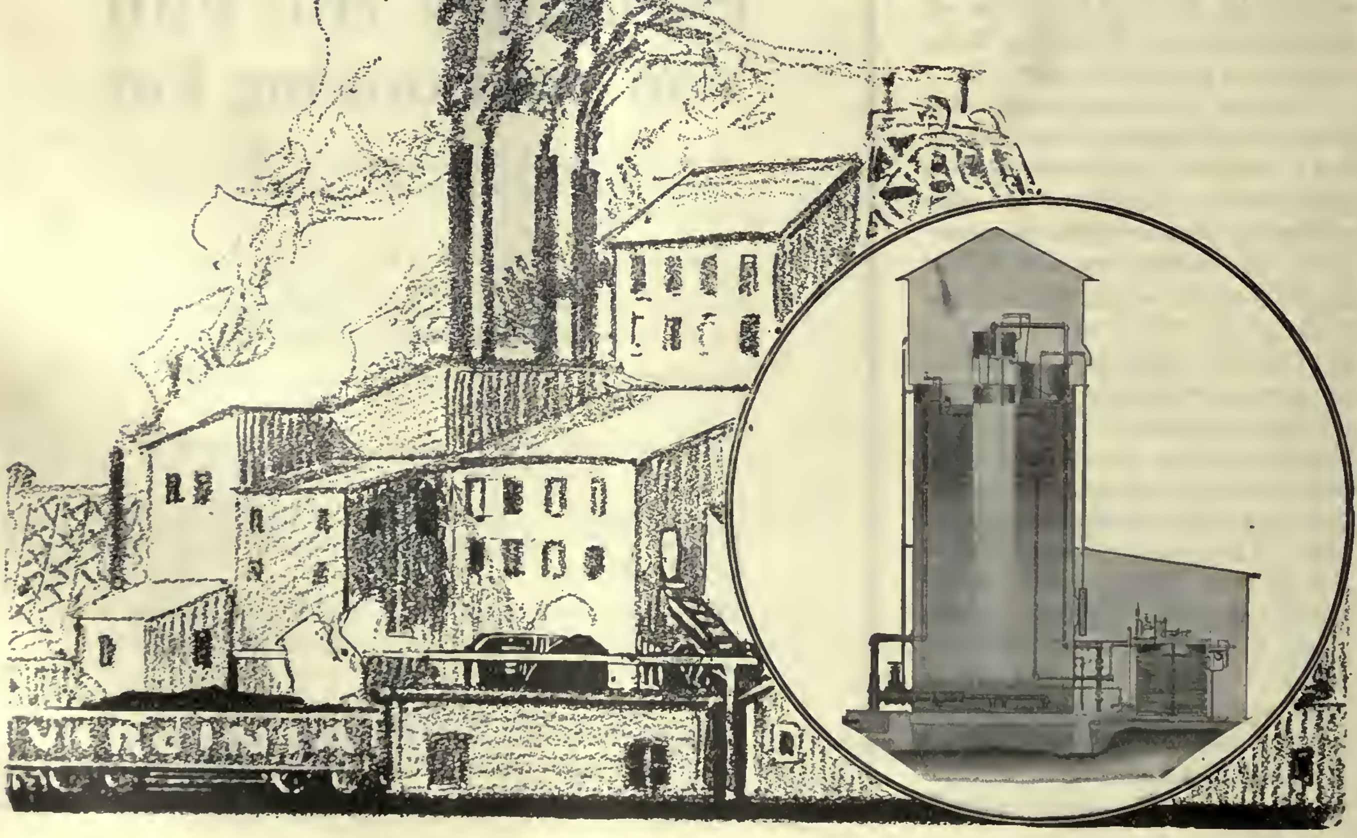
endeavor to show why under such conditions viscosity should be the preeminent consideration. Theoretically the molecular construction of petroleum oil is spherical and these molecules roll on one another, following the ball-bearing principles of low friction coefficient. While this friction coefficient is low, if it were less there is still friction; but it is less in a light-bodied oil than in a more viscous oil. We have, therefore, to consider not only the resisting friction of the metal parts to be lubricated, but also this oil friction. Generally speaking the higher the speed of the opposing metal contacts the less viscous should be the lubricant, the reason for which is the greater internal friction of one oil as compared to another, which is due to the molecular cohesiveness of the product; and this feature is the regulator of, and is determined by, the oil's viscosity. This being the case, in a quickly sliding or revolving mechanism the oil should be of such nature in its viscosity that it will rapidly succeed itself; i. e., the following oil moves quickly forward to replace and accept the position vacated, due to the forwarding influence of the moving contacts.

It can be understood readily that there is no advantage in having the metal surfaces separated by any space which is greater than that minimum space required for complete and absolute non-contact. If the body of the lubricant is of a viscosity greater than that necessary to perform this minimum separation, the user automatically increases the internal oil friction. This results in a greater pull on the power plant to overcome this feature, and is unnecessary and represents wasted energy. The average consumer may feel that the point involved is too fine for material consideration; but when it is realized, especially in plants having considerable lubricated machinery, that every additional ounce of oil too viscous for the situation represents additional waste, this fact should be considered. In suggesting the utilization of thin oils, this term is used comparatively, and is simply intended to reiterate with different phaseology the principles, sponsored by the late eminent Doctor Thurston, than whom perhaps no greater authority on lubrication has been known, that the consumer should utilize the least viscous oil that will keep the two metal surfaces separated. It is quite true, due to speed, weight, fit, surfaces, etc., that a so-called highly viscous oil may be necessary to fulfill this requirement, and it is simply desired that emphasis be placed upon the fact that nothing is more necessary than just separation.

The method by which lubricating oil is introduced to the engine parts has a great bearing on the grade and viscosity of the lubricant which may be utilized. If for instance the oil be applied through the medium of the common sight-feed cup, so adjusted as to permit of one drop of oil at various intervals, it is probable that a more viscous oil would be necessary than if a continuous system was employed. By the former method each drop of oil added must bear sufficient internal resistance to separation (viscosity) to enable the oil to retain its position between the surfaces to be lubricated until renewed or replaced by the succeeding drop; whereas, in the latter method, the flow of oil insures a constant presence and interference between the metallic surfaces to be lubricated, thereby permitting an oil of less viscosity.

Economy of power generation therefore, in so far as it may be influenced by the lubricant and the system of lubrication employed, is incurred by utilizing a continuous system instead of the spasmodic, with the proper corresponding reduction in viscosity of oil.

There are several local conditions which must be considered in the selection of oils best adapted for the lubrication involved. A product entirely satisfactory in one place may be criminally wasteful in another,



even though it be a high quality oil of its class. For instance, some features governing the selection of oils may be cited as illustrations:

Steam Cylinder Oils.—Moisture in steam; piston travel speed; reuse of exhaust steam; temperature and velocity of steam; size and weight of pistons.

Engine and Speed Oil.—Speed; close or loose fit; method of application; style of engine; weight and pressure of parts, etc.; and type of filters.

THE MEN AT THE FRONT

Men Whose Help You Need in the Buying and Installing of Equipment. Where They Are and What They Do

Roy Jacoby, a man with a broad knowledge of coal stripping work and equipment, has taken the place of Richard Blight, in the Chicago branch of the Marion Steam Shovel Co. Mr. Jacoby's experience in the actual designing of excavating equipment and its operation, has made his advice much sought after by coal stripping companies. While his headquarters are in Chicago, about half of his time is spent in the coal stripping districts.

Richard Blight, formerly of the Chicago branch of the Marion Steam Shovel Co., has been appointed manager of the Seattle branch.

Alfred Kauffman, who formerly looked after the Link-Belt Co.'s business in the eastern coal mining fields, and particularly in the West Virginia field, is now vice-president of the Link-Belt Co. and in charge of operations in Indianapolis. Mr. Kauffman served in the engineering department for a number of years, from which he was promoted to take charge of the erection work. His many friends in the industry undoubtedly will be glad to learn that in recognition of his competent and able work he has been elected vice-president of the Link-Belt Company.

Wm. C. Brandt, formerly of the Philadelphia office of the Electric Storage Battery Co., manufacturers of the Ironclad-Exide Battery, has been made manager of their new Pittsburg sales office in the Keystone Building, Pittsburg, Pa. Mr. Brandt is an Annapolis man and received his electrical education at the United States Naval Academy, class of 1911.

Beginning May 15, 1915, Francis H. Coffin & Co., Board of Trade Building, Scranton, Pa., will represent the William B. Pierce Co., Buffalo, N. Y., for the sale of the Dean Boiler Tube Cleaner and the Hays Gas Analysis Instruments. Mr. Coffin is well known among coal mining men in Pennsylvania, and the addition of power plant equipment to his other lines places him in an unusually favorable position to serve the mining operations in the territory he covers.

Coal in the Philippine Islands in 1913

No coal was produced commercially in the Philippine Islands in 1913. On Cebu, exploration work has been carried on under the direction of the division of mines of the Bureau of Science. During the fiscal year ending June 30, 1913, 459,583 metric tons was imported with a value of $1,196,959. About 65 per cent. of this came from Japan, and the balance, except in insignificant quantities, came from China and Australia. The importation of coke amounted to 11,572 metric tons, worth $43,017. The Manila Gas Co. manufactures about a thousand metric tons of coke and has a by-product plant using Australia coal. Coal retails at from $6 to $7.50 a ton. The Manila gas-house coke sells for $15 per ton while the best Connellsville coke brings $30.

Coal Resources of Canada

*By Frank D. Adams**

While Canada contains abundant supplies of coal, the coal beds are chiefly in more or less inaccessible regions. Investigations in connection with the meeting of the International Geological Congress, 1913, show less than 1 per cent. of the coal resources of the Dominion situated in Nova Scotia and New Brunswick, while 87 per cent. lie in Alberta, much of this coal being in very remote districts of these provinces.

The coal seams now being worked are those which contain the coal of the best quality and in the most accessible regions and those which are nearest to what are and always will be the great centers of population in the Dominion. They are, therefore, speaking generally, the deposits from which coal can be delivered most cheaply. When coal can no longer be obtained from these districts, or if for any reason it becomes more difficult to extract coal, the price will tend to rise.

In a coal bearing district, the measures usually contain several distinct coal beds, often differing more or less in thickness and quality. Selection of the most easily worked bed for mining may make impossible the recovery of coal from other beds, with the final result that a very small percentage of the coal in the area is won.

Again, there are beds of coal in Canada which are so thick that it is difficult, in fact in some cases impossible, to work the whole thick-

*From address before Commission of Conservation, Ottawa, January 19, 1915. From Bulletin, Canadian Mining Institute, March, 1915.

ness of the seam at once. Consequently the upper or lower part of the seam alone is worked, leaving the rest behind. In such cases, when the workings collapse after the cessation of mining, there is a serious danger of losing the coal in the other half of the seam. The loss, however, even under these circumstances can be minimized if a proper and uniform plan of working the seam is adopted from the first.

It may be said that in the coal fields of Nova Scotia the amount of coal which has been wasted is at least as great as that which has been extracted. This is apart from and in addition to the coal necessarily left in the mine under the method of mining employed. Most of this waste took place in the earlier years of mining in this province when there was no effective governmental supervision. At the present time, every mining company operating under lease from the government of Nova Scotia must submit in advance the plans which it is proposed to follow in opening up any coal seam, which plans must be approved by the Chief Inspector of Mines.

Such supervision is not required in the provinces of Alberta and Saskatchewan, the opening of which is just beginning and whose mineral wealth is the property of the Dominion Government by whom the right to mine for coal in certain areas for a certain definite term of years is leased. The duty of the inspectors under the Dominion Government is principally to collect royalties, while the functions of the Provincial Inspectors are principally the physical safeguarding of the miners. Thus the mining methods are not controlled, and wasteful mining is possible.

From the coal which is mined and burned under boilers in the usual manner, only about 12 per cent. of the total efficiency is developed. And if, as is usually the case, only 50 per cent. of the coal is taken from the mine, there is secured only about 6 per cent. of the total efficiency of the coal obtained in the area worked. If the coal is burned in gas producers and the gas so obtained used in internal combustion engines, a higher efficiency, amounting to about 30 per cent. of the energy in the coal actually mined, or about 15 per cent. of the energy locked up in the coal of the whole area is obtained. This is a distinct advance in efficiency but still represents an enormous waste. It is a waste, however, which at the present time we are unable to avoid.

In Canada by-product ovens are used by the Dominion Coal Co., at Sydney, and by the Algoma Steel Co., at Sault Ste. Marie, but these are the only ovens of this type in the Dominion.

There are at present in Canada, 2,024 ovens, which do not save the by-products, as against 730 which do save these valuable constituents of the coal. In Western Canada there are 1,935 ovens of the former class and none of the latter.

Mr. E. E. Lucas, manager of the coke ovens of the Dominion Coal Co., estimates the saving effected by the use of the by-product oven to be \$1.93 per ton of coke made. The by-product coke ovens of the United States produced in 1912 ammonia and ammonium sulphate to the value of \$9,519,268.

For some years past in England and Germany, attention has been paid to the problem of securing the largest possible yield of ammonia from coal during the process of coking. With the methods of coking ordinarily adopted at the gas works in these countries only about one-sixth of the nitrogen in the coal is obtained in saleable form as an ammonium compound. It has been found, however, that by employing certain improved methods the yield of ammonia may be increased by as much as 200 per cent.

The provision of an adequate supply of cheap fuels for the plains districts of Canada is an important problem. Large areas of these provinces are underlain by beds of subbituminous coal and lignite estimated to contain 100,000,000,000 tons. As yet practically all the fuel

in that portion of the plain east of Brandon is imported from the United States, while that used in the country west of Brandon comes from Rocky Mountain coal fields. In either case, the cost of transportation is high.

The beds in these districts have not been extensively mined, largely because of the absence of timber, and also because the coals are of a lower grade than those from the Rocky Mountains. Because of their disintegration on exposure to air, briquetting would be necessary to make them available for domestic use, and for the generation of power they would need to be briquetted or used in the gas producer.

A series of trials recently carried out by Doctor Porter and Professor Durley, of McGill University, for the Mines Branch of the Department of Mines at Ottawa, show that these fuels are excellently adapted for use in the gas producer and are thus well adapted for the production of power. The question of briquetting in a commercially profitable manner has not yet been settled.

Note.—It is interesting to note that Alberta produced in 1914: lignite, 1,697,401 tons; bituminous, 1,953,367 tons; anthracite, 170,971 tons; coal used in coke, 44,249 tons; coke produced, 29,058 tons; briquets, 109,082 tons.

Principal Sources of Coal Dust in Collieries

1. Undercutting and loading coal.
2. Hauling coal to the shaft or drift mouth.
3. The disturbances caused by the traffic of men, horses, and cars.
4. Gradual disintegration due to air-slacking and pillar work.

The third annual joint field meet of the United States Bureau of Mines, the American Mine Safety Association, and the California Metal Producers Association will be held at the Panama-Pacific Exposition, September 23 and 24.

Examination Questions

(Continued from Page 621)

that no one could enter the workings until the cause of the uncommon trouble was discovered and the danger removed.

QUES. 6.—What proportions of atmospheric air and methane are necessary to form an explosive mixture? At what point is the explosive mixture greatest?

ANS.—It is impossible to give a direct answer to this question as so much depends upon conditions that are not stated. In pure air and using an electric arc to ignite the gas, it is possible to secure a slight burning with as little as 4.5 per cent. of gas, and an explosion, but not with great violence, at 5.5 per cent. Competent authorities give the lower explosive limit at 5 per cent. and at 6 per cent. of gas, and others place it at over 7 per cent. It will be found that, owing to the deficiency of oxygen and the presence of inert gases like nitrogen and carbon dioxide in mine air, it requires a higher percentage of methane to cause an explosion underground than it does in pure air on the surface. On the other hand, the presence of coal dust increases the explosibility of methane so enormously, that even 1 per cent. of gas is considered highly dangerous in dry and dusty workings.

When the air is pure, the maximum degree of explosibility is reached when it contains 9.46 per cent. of methane; but a shortage of oxygen, presence of inert gases or of coal dust, affects this in the same way as it does the lower explosive limit asked for in the first part of the question.

QUES. 7.—If an open light is placed in a large body of marsh gas (CH_4) unmixed with air, what would be the result? Give your reasons.

ANS.—A light placed in a body of pure methane would be instantly extinguished, as this gas does not contain the oxygen which is necessary for combustion.

QUES. 8*.—The mine chemist reports that the return air contains .35 per cent. of methane. If the volume of air in circulation is 150,000 cubic feet per minute, and the daily output of coal is 3,000 tons, how many cubic feet of methane are given off by the mine per day and per ton of coal produced?

ANS.—The volume of air passing through the mine in a day of 24 hours is 150,000 × 60 × 24 = 216,000,000 cubic feet. The volume of methane given off per day would, thence, be 216,000,000 × .0035 = 756,000 cubic feet.

The volume of gas per ton of coal produced would be 756,000 ÷ 3,000 = 252 cubic feet.

QUES. 9.—If you were acting as fire boss, and had an entry driven 200 feet off the last cross-cut, and found in your examination that the entry contained explosive gas back 100 feet from the face, how would you proceed?

ANS.—There is something wrong with the foreman or with the mining law when entries in gaseous mines are driven 200 feet ahead of the air. The miners should be kept from the place and a line of brattice carried from the cross-cut to the face along one side of the entry. This work should be done with safety lamps or, better, with electric lamps. As soon as the face is free from gas, a cross-cut should be driven to the return at that point, and the previous cross-cut closed with a permanent brattice.

QUES. 10.—Is it safe to pass a current of intake air through the abandoned portions of a mine and then conduct it to the face of the workings?

ANS.—If the air-currents have always been carried through the old workings and the proportion of methane is below the danger point, there is no objection at all to the practice. In fact, from the standpoint of ventilation there are in this mine no old workings as they have, and always have had, live air-currents passing through them; or, in another way, the parts of the mine from which the coal has been extracted are used as an intake, which is perfectly proper. Old workings are only dangerous when they are not ventilated, in which case they are sure to become filled with either blackdamp or methane, or both. Then, if the air is diverted from its regular course through these workings and afterward is lead back to the face, there will be grave danger until such a time as the noxious gases have been swept out of the old workings, when the danger will cease.

QUES. 11.—The temperature at the inlet airway of a mine is 60° F. and 80,000 cubic feet of air per minute is entering the workings; what should be the quantity at the outlet if the temperature at that point is 70° F.?

ANS.—The pressure remaining unchanged, the increase in volume is proportional to the absolute temperatures at the intake and return, and is

$$80{,}000 \times \frac{460+70}{460+60} = 81{,}538 \text{ cubic feet.}$$

QUES. 12*.—How would you proceed to erect a regulator in one of a

pair of entries so that each might receive the same quantity of air, and what calculations would you make?

ANS.—I would not make any calculations. Let the entry through which the greater volume of air is passing be called B; it is evident that the quantity of air passing in this entry must be reduced in order to increase that passing in the other entry A. At some convenient point in B securely fasten two pieces of scantling across the entry at distances of 6 inches to 9 inches from the roof and floor, respectively, and to these nail pieces of plank set vertically. As the planks are successively nailed on, the quantity of air passing in A will be increased while that in B is decreased as its area grows smaller. The nailing of planks should be continued until the quantity of air passing in the two entries is the same, or as nearly the same as is necessary. If a more elaborate sliding door, or shutter, regulator is desired, the size of opening between the planks may be used to estimate the size of the shutter.

QUES. 13.—What would be the first thing to observe on entering each entry for examination?

ANS.—The first thing to observe would be whether the usual quantity of air was passing; if not, an investigation into the cause of this should be made before inspecting the rooms for the presence of gas.

QUES. 14.—Two airways each have an area of 64 feet and their lengths are each 3,000 feet, one circular and the other square; is there any difference in their rubbing surfaces? If so, how much?

ANS.—The square airway has the larger rubbing surface.

Each side of the square airway is $\sqrt{64} = 8$ feet long; its perimeter is $8 + 8 + 8 + 8 = 32$ feet; and its rubbing surface is $32 \times 3{,}000 = 96{,}000$ square feet.

The circumference of the circular airway is Cir. $= \sqrt{4 \times \pi \times \text{area}} = \sqrt{4 \times 3.1416 \times 64} = 28.37$ feet; and the rubbing surface of this airway is $28.37 \times 3{,}000 = 85{,}110$ square feet.

Hence, the square airway has the larger rubbing surface by 96,000 – 85,110 = 10,890 square feet.

Ques. 15.—On your examination of a mine generating explosive gas you find the ventilation in good condition, and no places containing any accumulation of gas, but as you are about to admit the workmen you discover that the ventilation has been interrupted by the stopping of the fan or otherwise; what would be your method of procedure?

Ans.—In a case such as this the only course is to keep the men from the mine until the trouble has been found and remedied; and before they are admitted, a second examination should be made.

Ques. 16*.—A mixture of marsh gas and air at its most explosive point, is passing along an airway 4 ft. × 5 ft., at a velocity of 500 feet per minute. What will be the volume of the current if it is increased until the percentage of marsh gas in it is not sufficient to propagate an explosion in the presence of inflammable dust? What would be the velocity of the increased air-current, and what kind of lights would you use for working on the entry?

Ans.—The exact percentage of methane that will propagate an explosion in the presence of inflammable dust is not definitely known, but is under 1 per cent.; the Consolidation Coal Co. endeavors to keep the percentage of methane in the return at not over .35 per cent. Assuming that an average of these figures of .675 is allowable, the calculation may be made.

The volume of air circulating in the mine is $500 \times (4 \times 5) = 10,000$ cubic feet per minute. At its most explosive point, methane constitutes 9.46 per cent. of the air. There would be, in this air-current, $10,000 \times .0946 = 946$ cubic feet of methane passing per minute.

That this volume of gas should be .675 per cent. of the air-current, this must have a volume of $946 \div .00675 = 140,000$ cubic feet per minute.

The velocity of the current would be $140,000 \div (4 \times 5) = 7,000$ feet per minute.

A velocity of 7,000 feet per minute is nearly 80 miles per hour, that of a hurricane, and work would be impossible. Assuming, however, that lights could be used, they would have to be of the portable electric storage-battery type, as no oil safety lamp would remain lit at any such velocity as this.

Ques. 17*.—A barrier pillar 25 feet thick is left between two coal properties, the boundary line between them being 1 mile long. How many tons of coal are there in this pillar if the seam is 6 feet thick and has a specific gravity of 1.3?

Ans.—The volume of coal in the pillar is $5,280 \times 25 \times 6 = 892,000$ cubic feet. Assuming the weight of a cubic foot of water as 62.5 pounds, 1 cubic foot of the coal will weigh $62.5 \times 1.3 = 81.25$, say, 81 pounds.

The number of tons of coal in the pillar will be $(892,000 \times 81) \div 2,000 = 36,126$ tons.

Ques. 18.—Give the names, symbols or formulas of (*a*) the common and (*b*) the rare mine gases.

Ans.—(*a*) The gases always present in the air, both within and without the mines, are, oxygen symbol O, nitrogen symbol N, methane formula CH_4, and carbon dioxide formula CO_2. To these three is commonly added carbon monoxide, which is really (and fortunately) a rare gas as it is formed only under unusual conditions; its formula is CO.

(*b*) The following gases are either uncommon or occur in very small quantities; some of them are given off by the coal and others are formed by the burning of explosives: Acetylene, C_2H_2; ethane, C_2H_6; ethylene (olefiant gas), C_2H_4; hydrogen, H; hydrogen sulphide, H_2S; nitric oxide, NO; nitrogen dioxide, NO_2; sulphur dioxide, SO_2.

Ques. 19.—What arrangements would you make on haulage roads for the safety of drivers and others? If employes are taken into the mine on empty trips, hauled by electric motors or other mechanical means, what should be the speed of the trips?

Ans.—The entries should be driven straight so that the track may be laid nearer to one side, so that a clear continuous space of not less than 2 feet, and better 3 feet, is maintained along one rib for the entire length of the road; also, a straight track reduces the number of accidents due to derailment, and permits of higher speeds and greater output. The passageway secured as described should be kept clean so that there is nothing to be stumbled over. At regular intervals of about 50 feet and on the wide side, should be made a series of openings into the rib not less than 4 feet in depth intended as safety or refuge holes from passing trips. These may be the mouths of rooms or breakthroughs (if at the right distance apart), should be kept clean of rubbish, and should be whitewashed; if electricity is available, they may have an incandescent light hung in front of them. The rails should be heavy, laid on sound, large, and closely spaced ties, so that the danger of derailment is reduced to a minimum; and the road bed should be kept in good repair.

The speed at which man trips may be safely run depends upon the condition of track and rolling stock. With a strictly first-class track and cars there seems no reason why speeds of 8 or 10 miles an hour are not perfectly safe; but everything considered, 4 to 5 miles is perhaps safer.

Effect of War

The statement is made by Dr. C. Schroedter, in *Stahl und Eisen*, that the Germans now hold control of about 40 per cent. of the aggregate industrial activity of France. These figures are based upon the percentage of steam plants under German control. It is claimed that Germany controls 68.8 per cent. of the coal, 78.3 per cent. of the coke, 90 per cent. of the iron ore, 85.7 per cent. of the pig iron, and 76 per cent. of the steel ingots.

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The Rossiter, Pa., Power Plant

A New Installation of the Clearfield Bituminous Coal Corporation, Which Shows Many Economical Features

Written for The Colliery Engineer

ONE of the most encouraging signs in connection with the coal industry is the attention being paid to the development of power. This is one manifestation of the progress which is converting the production of coal from a commercial adventure with something of a gambling element about it, to a stable industry in which visible leaks are stopped and demonstrated economies adopted.

A large part of the cost of the production of a ton of coal is chargeable to power consumption, and, with the rapid development and adoption of mechanical devices, the proportion of the total cost thus chargeable is increased; therefore anything tending to decrease the cost of power production is of great importance. In many places the old style of power house, dirty, dark, poorly arranged and inefficient, is still found, but fortunately the power plants now being installed are entirely up to date, well arranged, well lighted, clean and efficient.

At Rossiter, Pa., the Clearfield Bituminous Coal Corporation has recently erected a new power house, the equipment of which is not yet complete. This, though not large, may well serve as a model for similar structures in the coal districts. It was laid out by Mr. J. W. Wetter, chief engineer of the company, and the apparatus was furnished by the Scranton Electric Construction Co.

Fig. 1. Rossiter, Pa., Power Plant

This plant serves three openings, known as mines 1, 3, and 4. These really constitute one mine, as they are connected. The coal from all is brought to one tipple. The capacities of these mines are, No. 1 about 1,100 tons, No. 3 about 900 tons, and No. 4 about 500 tons. No. 4 is practically exhausted as far as the first working is concerned, and most of its output is pillar coal. Mines Nos. 1 and 4 are near the power house and the line to No. 1 is fed with direct current from the converter. The line from No. 4 is fed directly from the generators with alternating current at 2,300 volts.

Because of the approaching abandonment of No. 4, it was thought unwise to install expensive machinery there, and the converting equipment consists of two 275-volt generators driven by belts from one 175-horsepower induction motor.

The line to No. 3 extends 12,000 feet from the power house and the current is stepped up to 6,600 volts. This line is protected by an electrolytic lightning arrester. The other lines are protected by multi-gap lightning arresters.

Another line to the Juneau opening has just been finished. This carries 2,300 volts.

The power house is built of a light yellow brick and is a very attractive building. The stack is also

of brick, 125 feet high, 6 feet 6 inches in diameter at the top and is beautifully built. The building is finished inside with whitewash made after the government formula, and every inducement is being offered to keep it as clean as it now is. The walls of the turbine room are provided with abundant window space, well placed, so that the interior of the room will be well lighted during the day time. The windows have steel sashes and are glazed with wire glass. Incandescent lamps are used at night and on dull days. These are placed as shown in Fig. 6. The cones of light from the rows of lamps along the walls intersect in the line of the ceiling lamps and those of the ceiling lamps in turn reach the walls at the elevation of the wall lamps. With this arrangement it is found that the room is thoroughly lighted and, a very important point, is practically without shadows.

The roof is supported on 24-inch I beams. These are heavier than trusses of the same strength but require less space, and their use resulted in the saving of about $400 in the cost of the walls. The floor is of 3-inch reinforced concrete on structural steel supports.

Fig. 2. Mine Car

Fig. 3. Behind the Switchboard

Fig. 4. Cable Supports

The plant has three 400-horsepower Keeler water-tube boilers, with Ajax shaker grates. Ashes drop from the ash pits to a car in the tunnel under the boiler room floor. The car is to be drawn out by a rope operated by a small hoist located in the boiler room, from which point the dumping of ashes into the car can be controlled. Fuel will be brought to the plant by a monitor hauled up grade by a rope operated by the same hoist used to pull ash cars from the tunnel. As the empty monitor will run out from the power house by gravity and the empty ash car will run back into its tunnel by gravity, the arrangement will be very simple. This monitor will automatically dump into the fuel bins opposite the boilers. The place of dumping will be controlled by triggers operated from the floor. Fig. 5 shows the concrete trestle for the fuel monitor.

As only one fireman is required to tend the boilers and one man to operate the hoist, the whole boiler room can be run by two men at most, and probably during most of the time one man can do all the work.

One of the most important points about this plant is the fact that the fuel is almost entirely track cleanings, marketable coal being used only when there is a failure in the supply of track cleanings, old ties and other combustible refuse.

All pipe is completely sectionalized with valves so that any unit can be cut out, thus it will be possible to cut out of service any one of the three boilers, either one of the two feedwater heaters, either of the two condensers, or either turbogenerator. In some plants the effect of loss of heat in the steam pipes on the cost of power production is neglected, but here every measure for economy is being taken and the steam pipes are insulated with felted sponge.

Two turbogenerators are used. The electrical end of each has a 600-kilowatt, 2,300-volt, 60-cycle, three-phase generator, direct connected to the turbine and running at 3,600 revolutions per minute.

Curtis turbines are used. These are rated for 150 pounds pressure but are run at about 170 pounds. They are run condensing but the exhaust lines are fitted with automatic valves which instantly open the exhaust to the atmosphere when the vacuum is lost. Each turbine is furnished with an emergency stop which automatically shuts off the

steam in case of overspeeding. This stop is fitted with two springs. One to shut off the steam at 10 per cent. overspeed and the other to operate at 15 per cent. overspeed in case the first should fail. After the machine has been stopped by this trip, it can be started by opening the throttle valve by hand. The apparatus is similar in what it accomplishes to the magnetic circuit breaker. All electrical machinery at the plant was manufactured by the General Electric Co.

Exhaust steam from the turbines goes to two "Spiroflo" surface condensers to which one dry vacuum pump is connected. All condensing equipment was supplied by the Alberger Pump and Condensing Co. From the condensers, water goes to a hot well, then to the pump which raises it to the feedwater reservoir on the boiler room floor, from which it is taken by the boiler feed-pumps. This reservoir is provided with a float valve which allows the admission of enough fresh water to make up for losses. It has been found that the addition of fresh water amounts to about 10 per cent. of the total evaporation. The cooling-water circulating pump and the hot-water pump are mounted on the same shaft with a small steam turbine.

The cooling water enters the condensers at about 88 degrees and leaves them at about 93 degrees. These temperatures will of course

Fig. 5. Concrete Trestle

vary considerably at different seasons of the year. The condenser water is cooled in a spraying tower situated at the rear of the power house and shown in Fig. 1. The water is pumped into this cooling tower under pressure and enters a central hollow shaft at the top of which are hollow arms provided with nozzles on one side. The force of the water leaving these nozzles causes the arms to revolve and the water is well distributed over the tower.

This tower is 19 feet in diameter, 32 feet high. It is furnished inside with 1″×4″ cedar boards, spaced 4 inches with alternating layers crossed. Air is forced through the tower by two disk fans, placed in opposite sides near the bottom, driven by a 440-volt induction motor.

The water supply is good and practically no trouble is experienced with boilers, condensers, or feed-

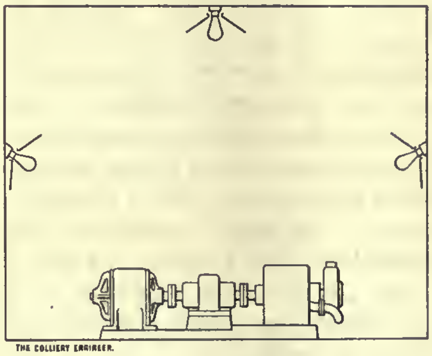

Fig. 6. Showing Arrangements of Lamps

water heaters. Little trouble would be experienced in the boilers and feed-water heaters because, as has been said, the supply of fresh water is only about 10 per cent. of the total evaporation. The tanks shown in Fig. 1 were a water treating plant used for water from a source which has been abandoned for boiler water supply, and is now used only to supply the town. The water is pumped up to the tanks located on a hill shown in Fig. 1, from which the town is supplied by gravity.

The generator bearings are cooled by water which after leaving the bearings goes to the entering line to the cooling water system. The generator sets are mounted on concrete piers separated from the floor.

The generators are cooled by air led through conduits which pierce the walls of the building on two opposite sides. These conduits are made with three compartments, the middle one for the entering air and the two outside ones for the return air. Dampers permit the short cir-

Fig. 7. Substation

cuiting of the air in times of extremely cold weather, when, without this precaution, the generators would become so cold as to condense and freeze the moisture in the air.

A motor generator set of 300-kilowatt capacity is used to supply direct current to No. 1 mine and the outside lines. It has an extra large synchronous motor for power factor correction if necessary. This supplies current at 275 volts.

Two 25-kilowatt exciters are provided, one driven by turbine and the other by an induction motor. The first is used when the main generators are started and the other is used after these have been brought up to speed and have been excited by the turbine-driven exciter.

The switchboard is of the remote-control, hand-operated type. No wire on the front section of the board carries more than 440 volts and all but one of the connections carry only 110 volts. Fig. 3 shows the space between the front and rear boards of the substation switchboard with the operating rods on the floor. With this form of board, danger to which the operator is exposed is much less than it is when the older form of switchboard is used. All A. C. circuits are fitted by oil switches. Each line and generator circuit is provided with disconnecting switches, so that it can be entirely disconnected from the rest of the board in case repairs are necessary. A Tirrill regulator is

used to maintain absolutely constant voltage under all conditions. The board carries a curve-drawing watt meter and an integrating watt meter.

The basement of the building contains the two condensers, pumps, and the step-up transformers used on the line to No. 3. It is intended soon to place shower baths in the basement.

One thing to be especially commended is the fact that the ground around the power house has been fertilized and seeded so that a good sod will be produced. This is something which is going to be done much more commonly in the future than it has been in the past. Those companies which have succeeded in initiating some idea of appreciation of neatness in mine camps testify strongly to the fact that it is not only a satisfaction to know that they are helping employes to live comfortably, but that such outlays actually pay financially in the increased work done by cheerful and contented men.

The company has at present one substation situated almost over the present face of No. 3 mine and two miles from the power house. This substation supplies power for the operation of mining machines in No. 3 and feeds the trolley wire about half-way back to the power house. The transmission wire is No. 3 copper. The substation as shown in Fig. 7 is substantially and neatly built of brick. Current reaches the station at about 6,000 volts. There are two transformer sets, one being intended as a reserve. These sets are similar to the one used in the power house except that the alternating current enters at about 6,000 volts.

Current is carried into the mine through a bore hole 250 feet deep. Six cables are used, three positive and three negative, and each 650,000 circular mils in area. The positive cables are insulated with varnished cambric capable of resisting 6,600 volts. The negative cables are triple-braided weather-proof. These cables are supported on wooden bars resting on concrete pedestals as shown in Fig. 4. The cables are insulated from the casing of the bore-hole by a 6-inch vulcanized fiber pipe. This substation also feeds a part of mine No. 1. The wiring is so arranged that the current can be cut off from any mine.

At present most of the mining machinery used is driven by electricity, but there are some air punchers used, especially for working pillar coal. Compressed air is furnished by a 1,500-cubic foot Ingersoll-Rand cross-compound compressor, belted to a 200-horsepower induction motor. Some of the fans are still driven by steam, but these, which are of a large diameter, are to be replaced at once with modern high-speed fans driven by 100-horsepower slip-ring induction motors.

The company has decided to adopt steel cars and these are replacing the wooden cars as rapidly as the latter are abandoned. Steel cars are made, on the same model as the wooden cars, of plates stiffened with angle irons. Fig. 2 shows the cars. Sixty-pound rails have been placed in No. 1 mine. In No. 3 mine the old rails, weighing 25 to 30 pounds, are being replaced with 60-pound rails.

All available means are being used to make the generation of power as economical as possible. Labor saving devices permit the reduction of the labor cost to a minimum. The machinery is all of the latest form and most efficiently designed, and is working in the most satisfactory manner. Flow meters are being installed on all steam and water lines so that the behavior of each unit will be exactly known. Draft gauges, made by the Precision Instrument Co., are attached to the fireboxes, and the flue gases are analyzed by a very convenient portable apparatus made by the same company. With this equipment it will be possible to know exactly how much water each boiler evaporates, how much coal it burns, the draft in each firebox, and the composition of the flue gases. With this information, the engineer can bring each boiler up to the most efficient conditions. The old power plant consumed 65 tons of coal per day. When all the intended changes are completed, the new plant will consume about 20 tons. This plant at Rossiter is a good example of what modern engineering can do for the coal industry. Not only is it as efficient mechanically as such a plant can be with existing machinery, but it is well built, neat and well kept.

Examinations on the Mine Law

The Susquehanna Coal Co. is completing a series of examinations of its mine foremen, assistant mine foremen, fire bosses and safety inspectors on the Anthracite Mine Law. Many of these men have been in the employ of the company for long periods and passed their state examinations many years ago, and the management of the company wanted to make sure that they were conversant with the mine law as it is today; the results have been most gratifying.

Certain pages of mine law are assigned as the subject matter for each examination, and the employes who occupy the responsible positions are given 3 months to prepare for the first test. The examinations are given by the division superintendents, and are written. They are held on idle colliery days, or at night, and the entire mine law germane to their duties is covered in the series. The interest and study shown by the employes has proved highly satisfactory, and in one of the divisions that reported recently only three men scored less than 100 per cent.

The quantity of soot deposited in a boiler increases as the draft under the firebox diminishes, but the flue dust increases as the draft increases. Both soot and flue dust are bad heat conductors. If the heat conductivity of silver is 100, the heat conductivity of carbon is .03, and a combination of soot and ashes about .55.

The Hojo Coal Mine, in Japan—II

Conditions Found After the Explosion, and the Methods Employed in Investigating Its Cause

By S. Meguro*

IT IS a very difficult matter to examine all parts of a mine as extensive as Hojo colliery, the underground area of which is 39 acres; and a long time is required to examine one by one all the miners and officers. This inquiry was really finished in a short time, as the miners actually at work on the day of the explosion were all dead, with the exception of 20 men. Though these men were questioned, it was soon evident that the true cause could not be learned from them. Also, as it seemed doubtful that such a simple inquiry and short examination of the mine would reveal the real cause of the explosion, I applied in this case the same method used in investigating the cause of the explosion in Futase colliery in February, 1913.

My method consisted in an examination of the condition and position of the adhering coke scale, and also of the condition and location of blown-out props, rails, haulage engines, pumps, tools, brattices, ventilating doors, air crossings, stoppings, lamp lighting places, smoking places, underground offices, falls of roof, and dead bodies. By the exercise of care and judgment, the direction of the explosion waves in the different parts of the mine can be learned. It is then plotted on the map and the direction of the explosive flame will be known. Moreover, by this study, with the consideration of the amount, form, and position of the adhering coke scale, it will be easy to distinguish the point of origin, the point of secondary explosions, the point of third explosions, the point of flame propagation, places where the explosive wave had great intensity, places where the flame had ignited the coal, etc. When by such means the working place or gallery in which the explosion originated is definitely learned, inquiry can be made from the miners and officers engaged in that place concerning all possible source of fire, such as safety lamps, blasting, electricity, spontaneous combustion, sparks from falling rocks, and the secret carrying of materials which might cause fire.

INVESTIGATION OF THE DIRECTION OF EXPLOSIVE WAVE

The general principles followed in determining the direction of the explosive wave are as follows:

(*a*) *Initial or Original Point of Explosion and Its Vicinity.*—At the point of origin and its vicinity, the coked particles are projected directly upon the exposed surfaces of timbers and walls, particularly upon the upper portions. This coked scale faces the originating point and may be as much as ½ inch thick. But on the reverse, or lee, sides of the timber, there are usually seen only a few scattered particles of coke, unless there has been some reflex action.

If the coal is of good coking quality, and there is abundant dust, the adhering particles usually form a thick loosely cohering scale. The coking of this scale has been carried only so far as to render the grains plastic enough to cohere and to stick lightly to the surface. A slight touch will detach and break the scale. The luster is dull and the appearance granular. The scale often contains pieces of shale or fragments of rock and wood. Again, at the point of origin the scale rarely adheres to the roof, but is usually attached to the under sides of the collars.

In general there are five kinds of coke produced in a coal-dust explosion, among which the first and second are found at the point of origin or in its vicinity.

The first kind of coke scale appears like a splash of mud upon the surface of a wall, and usually adheres to the ribs and to a less extent to the roof. It indicates an abundance of dust and intense heat, but not much movement.

The second kind of coke may be found near the origin of the explosion, or where there have been secondary explosions. It adheres to the exposed surfaces of the walls and timbers facing the source of explosion. This coke is less friable and consists of dust caked by the melted bituminous matter. It indicates an abundance of dust but not much movement.

(*b*) *Point Distant From the Point of Origin.*—When a flame proceeds through a gallery, the air wave or a blast preceding the flame stirs up the fine coal dust from the roof, sides, and floor, and forms a dense cloud of dust. If the flame is supplied with such a new dust cloud, its propagation is continued, the velocity is increased, and the flame finally rushes out of the shaft mouth, passing through the least resisting parts of the mine. In this case, as the velocity is great, coked scale is not deposited on surfaces facing the advance of the explosion, but adheres as a rule to the reverse or lee side. The scale is uniformly thin and bright.

The explosive wave is not produced by adding a volume of gas from outside, but arises from the

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Fig. 1. Map of Hojo Mine. 1 Inch = 854 + Feet

Note.—Right and left as represented on this map are as viewed from the top downward.

fact that, as the mine air is heated by the flame, its temperature becomes very high, reaching 1,000° C. to 2,500° C. and its volume expands from three to seven times its original bulk. After the explosive wave has passed, the heated gas is cooled by the surrounding rocks and begins to contract, creating a partial vacuum. In order to fill this vacuum the air moves in a track the reverse of that of the explosive wave, producing a strong current. When this reverse current of the air attains a considerable velocity it carries fine coal dust with it, and deposits the dust on the lee, or reverse, side of the props.

If the coal cokes well, forming large grains, like that of Yubari or Futase, it is easy to determine with the naked eye. But as the Hojo coal does not coke at all and its grain is very fine, it is not easy to determine whether it is coked or not. The only way to distinguish coke scale from coal dust in the mine is by the fact that the coke scale has a metallic luster when illuminated by an electric lamp, while the coal dust shows a dull color. In the most important case, samples were collected from both sides of props and examined under a microscope or analyzed chemically.

The reverse current does not necessarily return over the path of the explosive wave, but in order to fill the vacuum the air comes from the nearest point; if there is a working face near, it frequently happens that the current carries in tin cans, baskets, papers, etc., from the working faces to the point of reduced pressure. At this stage coked particles may be driven into crevices in the ribs or into cracks in the timbers.

As the velocity of the explosive wave increases, it no longer deposits coked dust on the sides of timbers facing the wave, except occasionally as scattered particles, but forms thin scales, often bright, on the reverse sides of timbers or projections.

At points distant from the origin, although the flame diminishes in intensity, yet if the wave still pos-

sesses its full velocity, the corners of brick walls and surfaces of timbers are shaved as if they had been acted upon by a sand blast. This shaved surface always faces the direction of the explosive wave.

The third kind of coke belongs to this stage. The particles are generally bright and always close enough to form a thin scale. Such coke indicates the final sweep of the explosive wave too strong to allow deposition on surfaces facing the wave but forming deposits of coke scale on the lee side.

When the flame reaches a newly formed dense dust cloud it causes a secondary explosion. The coked scale adheres on surfaces facing this secondary explosion, but as the velocity of the wave is great at this stage, the adhering scale is shaved away by the force of the wind and shows the forms of prisms, prismoids, and similar shapes, according to the relative position of the scale to the direction of the wind. At this stage the position of the scale is not necessarily on the lee side, but mainly it faces the direction of the wind or faces parallel to the wind. For this reason a very careful investigation is required to find out the true direction of the wave at this stage. The relation of position of scale to the direction of the wave at

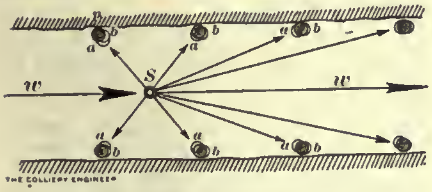

Fig. 2. Relation of Position of Scale to Direction of Explosive Wave

w, direction of explosive wave; *S*, point of secondary explosion; *p*, props; *b*, coked scale deposited by explosive wave *w*; *a*, coked scale forming prisms caused by secondary explosions.

Fig. 3.

w, direction of explosive wave; *p*, cross-section of prop; *b*, the coked scale deposited by the secondary explosion; the dotted part being shaved away by the force of the wind and leaving a prism.

this stage is illustrated in Figs. 2 and 3.

(*c*) *Points Farthest Distant From the Point of Origin.*—When the velocity of the explosive wave gradually decreases and begins to die out, the coked dust does not adhere to the lee side of timbers and projections, but adheres to the side facing the wave. Also if the explosive wave reaches out to some wide opening, such as the working face in the longwall system, after passing through a narrow entry, then the velocity of the wind rapidly decreases and the coked scale adheres to surfaces directly facing the wind as illustrated in Fig. 4.

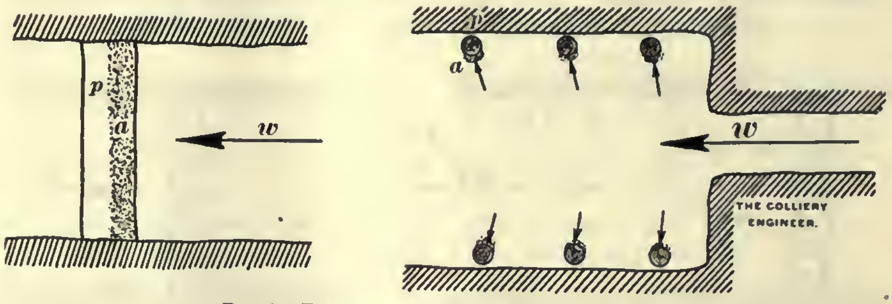

Fig. 4. Elevation of Prop and Plan of Gallery

w, explosive wave; *p*, props; *a*, coked dust adhering to sides facing the wind.

The fourth kind of coke is formed in this stage. Minute globules of coke from 1/32 inch to 1/16 inch in diameter are produced if the coal is strongly coking. These globules are perfectly round and their interiors are nearly hollow, consisting of one or more air cells. Such globules attach themselves to surfaces facing the wind, as showu in Fig. 5.

These globules are like tiny balloons and do not adhere together, because they are cooled in transit through the air. Sometimes they are attached to the roof by melted bituminous matter and hang down as shown at *a* Fig. 5, and may be found on the roof between timbers or on the lee side corners of the gallery. If the globules fly as far as the gas at the end of the gallery they may cause a gas explosion. This kind of coke was observed in the explosion of Futase colliery, in February, 1913.

The fifth kind of coke also belongs to this stage. This kind of coke is formed where the flame of the explosion has lingered and the adhering coked dust has ignited the standing coal, sufficient oxygen being present for the combustion to go on. Much care is required to avoid the mistake of ascribing this form of coke to the point of greatest intensity of explosion.

When the coke is cooled in transit, it loses its plasticity and falls down to the foot of the prop, after striking the lee side of it, in the form of a pyramid as shown at *a* in Fig. 6.

When the explosion wave penetrates into a room or other portion of the mine and dies away, the supply of oxygen being insufficient to allow complete combustion, then the coke particles are found hanging in loose threads from the roof. This is evidently the result of deposition of coke particles in still air after the explosion. This is called stalactitic carbon.

Direction of Explosion Wave

The investigation of the direction of the explosion wave was carried out according to the principles just mentioned, taking into consideration the amount of adhering coke dust, its position, its form, the position of articles dislodged by the explosion, falls of roof, etc. This investigation was commenced immediately after the explosion, and progressed with the work of exploring the mine until the present time (February 12, 1915).

1. The New Kuroki incline and New Oyama incline.

The explosive wave, as indicated by arrows on the underground map, originated at the working face of the 7½ oroshi, or incline, on the right 16th kata, or level, and blew from right to left, through every level from right 12½ level to 17th level. The wave proceeding to the left

through the left 15th level and blew in the 2d New Oyama incline to the 2d New Kuroki incline from the upper to the lower portion. In this quarter of the mine, the falls of roof and the amount of cohering coke dust were very abundant.

Now the reasons for deciding upon

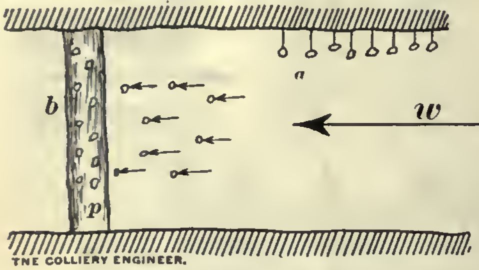

Fig. 5

a, coke globules hanging from roof.
b, same attached to surface facing wind.
w, explosive wave.

the 7½ incline as the point of origin of this explosion are as follows:

This incline 7½ extends only 36 feet from the 16th level, is 9 feet wide and 8 feet high. Its dip is 18 degrees. At present a small quantity of water has accumulated at the bottom of the working face. The coal in the roof of this place had been ignited and coked. The bituminous matter melted by the heat of ignition was hanging down from the roof like threads to the length of 1 inch. A large amount of coke and soot had adhered to the face and to both walls of the incline. Since there were no props at the face, there was no opportunity to find adhering coke scale, but in the neighboring gallery there was coke scale deposited upon the surface of the wooden "road." This coke scale faces toward the face of incline 7½. The brattice in the incline 7½, built of planks, props, and straw matting, had been broken into small pieces and blown against the right side wall of incline 7½ and that part of the 16th level facing toward incline 7½. From these facts it is ascertained that the explosion wave passed out from incline 7½.

It was thought possible that the working face of the 16th level was a point of origin and I examined this face very carefully. It was found that the roof coal had been intensely ignited and that the surface was coked. Also that abundant coked dust was attached to both walls. But from the fact that two coal cars on the track of the 16th level, and the brattice which had been constructed in front of the face, had all been broken into small pieces and

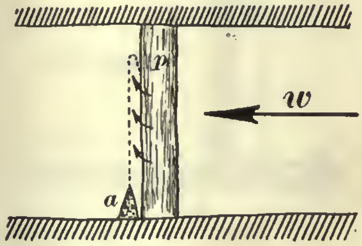

Fig. 6

a, coke pyramid.
p, prop.
w, explosive wave.

blown against the face, and that clay in front of the face was blown against it, it is evident that the explosion wave blew toward this face.

From the fundamental principles of adherence of coke, it is evident that, in the place of origin or this vicinity, a thick attached coked scale faces the origin, and that on the reverse side only a few scattered grains will be found, indicating an abundance of coked dust and intense heat, but not much movement. On the front surface (which faces away from the end) of three props which were standing on the left side of the working face at the 16th level, a thick coke scale was found, while on the back surface, which is the surface toward the end, there were only a few scattered grains of coke, perfectly round in form.

From these facts it is clearly evident that the end of the 16th level was not the point of origin and that the true point of origin must have been in the neighborhood of incline 7½.

In the 4th incline, the wave clearly moved upward. But though adhering coke scale could be plainly recognized up to the 11th level, from the 10th level, where a fault is passed through, to the 8th level where a self-acting plane is located, and to the communicating road of the 7th level of the right Mata incline, adhering coke is very scanty or absent, because of the dampness of this quarter of the mine. Therefore, from the study of the adhering coke, I cannot at all determine the direction of the wave. Notwithstanding the above objection, it became evident from the precise investigation afterward made that the coal car filled with coal and the timbers were all blown against from below upward. Accordingly, I have determined that the wave in the 4th incline moved upward.

Again in the 15th left level the wave blew upward from the interior. In the New Kuroki incline and the New Oyama incline, the wave also blew upward. As the New Kuroki incline has been used as a main haulage road for coal produced from the 2d New Kuroki incline and 2d New Oyama incline, accumulated fine coal dust was abundant. Hence the explosive wave exhibited very great violence. For this reason considerable falls of roof occurred at every intersecting point of the incline with levels 3, 5, 6, 7, 8, 9, and also below 9th, 10th, and 11th levels. At the 4th level an overcast built of brick was thoroughly blown up, and the wave, after having wrecked a 100-horsepower electric hauling engine and its room, passed out through the Oyama incline and Kuroki incline.

On the other hand, in the New Oyama incline, which is parallel to New Kuroki incline and was used only for drain pipes and cables, there was no considerable accumulation of coal dust, and the fire of the explosion was very weak and could not sweep away the props which had been set in that incline, and caused a roof fall only at the 11th level and right 3d level. Moreover, the amount of adhering coke was so scanty that it could scarcely be determined that the wave moved upward.

In the left quarter of New Kuroki incline, left 11th level, 10th level, 9½ level, the wave had blown toward the left from the New Kuroki incline. In every incline it blew upward, especially in the left

diagonal incline it blew from below upward. It passed through left 10½ level, second incline; left 9th level, first incline, the overcast of the 5th level and 4th level; and combined with the wave which came from the lower portion of New Kuroki incline, passing through the broken overcast at the 4th level.

As the above passage, before the explosion, corresponded to the return airway of the 2d New Kuroki incline quarter, if the gas emitted from the 2d New Kuroki incline, left 21st level, and 4½ incline, had caused the explosion of this time, the return airway, which had a direct connection to the gas, must have been greatly destroyed by the violence of the explosion wave; but, on the contrary, this airway was not destroyed at all and there was no adhering coke scale. The props remained in place in the greater portion of the airway. The above facts evidently show that the gas which issued from incline 4½ did not originate the explosion.

In the interior portion of New Kuroki incline at the left 10th level, spontaneous combustion had occurred a few years ago. At that time all passageways, which communicated with the gob fire, were filled by sand flushing; and at the left 9½ level, 2d incline, left 11th level and left Diagonal incline, which also communicated with the sand flushed part, pack walls were constructed with shale and plastered over with clay and lime. Now on examining these pack walls, it was found that they had undergone no changes, hence it could be clearly recognized that the fire of the explosion did not originate from the fire communicated from this spontaneous combustion.

In the four inclines, the Togo, Kuroki, Oyama, and the 1st, the wave blew from below upward, and the violence of the explosion is indicated by the extensive roof falls resulting from blowing away of props, the abundance of adhering coke, etc.

Especially the office, which was located between the 3d level and 4th level of Kuroki incline, was totally broken to pieces. Six tables, 35 chairs, and 5 boxes were all broken into simple fragments of wood and blown away, leaving slight traces of them. The surfaces of books were burned black, but dynamite in the room remained unexploded.

The wave which moved up the 4th incline, split into two parts at the 8th incline. One passed up the New Oyama incline after passing through the self-acting plane of the 8th level; the other went out into the 7th level of the Right Mata incline. This road is a gob road with an abundant accumulation of coal dust and gas. When the flame of the explosion reached this point, it generated a secondary explosion and the wave blew out the 7th incline of Right Mata incline in one direction, and on the other side the wave blew over the same road as before in reverse direction, that is, from right to left and finally passed out the 1st incline after passing through the 5th level, 4th incline; 4th level, 4th rise; and 3d level. As in the gob road there is a smell of spontaneous combustion, the passage is always warned against. Though it was advisable that this road be examined, at the time of the explosion great roof falls and large accumulations of gas at the top of the falls made it inaccessible. When the road is thoroughly opened, it will be examined again.

Each different district of the mine was examined with the same care as to details, and all the facts as to damage done by the explosion, the deposits of coke and dust, etc., were carefully noted.

In every case the route of the explosion could be traced, as shown by the arrows on the map, from its connection with the part of the mine where the original explosion was thought to have been; and while there were indications of a number of secondary explosions, there was none where conditions permitted the conclusion that it could have been the original one, except at the face of incline 7½, as already stated.

INVESTIGATION OF THE CAUSE OF IGNITION

There are six principal sources of fire in mines, viz.: 1, spontaneous combustion; 2, sparks produced by falling stones; 3, electricity; 4, blasting; 5, bringing in fire-producing materials; 6, safety lamps.

1. *Spontaneous Combustion.* Spontaneous combustion had occurred in this mine a few years ago at the interior part of New Kuroki incline, left 10th level where the coal seam was ground to dust by a fault. The temperature at that point increased gradually, and smoke and fire resulted. At that time, as a method of extinguishing the fire, a gallery was opened near the fire and completely surrounding it. This gallery was packed with sand flushing and all passageways communicating with the flushed gallery were packed with shale and stone and plastered over with clay and lime.

I examined the plastered dams of left 11th level and New Kuroki incline, Left Diagonal incline, left 10th level, 2d incline, left 9th level, and 3d incline, and found that the walls had undergone no change. Therefore, it may be recognized that spontaneous combustion here was not the source of fire causing the explosion.

Also the odor of spontaneous combustion was once emitted from the gob road of the 8th level of New Kuroki incline, but up to this time no fire had occurred. Therefore, this road cannot be recognized as the source of fire. This is the more certain as these two places are far distant from the origin of the explosion as previously stated.

2. *Sparks From Falling Stones.* There are some who insist that the explosion at Senghenydd, which killed 439 men on October 14, 1913, was caused by a spark from falling stones. Though sparks may be caused by falling stones, it is doubtful whether these sparks can ignite gas. In Hojo colliery there was a great abundance of fallen rock caused by vibration of the explosion, and it could be seen that nearly all of these falls had not occurred be-

fore the explosion, but there is no possibility of distinguishing that which fell in advance from that whose fall was caused by the explosion. All the rock of the roof, however, is soft, consisting principally of the Nanaheda coal seam and shale, rocks which do not emit such sparks as the hard rock of the Carboniferous formations at Senghenydd. Moreover, as at the point of origin incline 7½ to right 16th level, there was not observed any great fall of rock, it is apparent that the explosion was not caused by sparks from falling rock.

3. *Electricity.*—The electrical machines and motors used in this mine are of a gas-proof type, which under ordinary running conditions never emitted any sparks at all, and as their superintendence and management are perfect, the explosion was not caused by a spark from an electric machine. Moreover, since at the point of origin no electrical machine was in use, it is apparent electricity was not the cause of the explosion.

4. *Blasting.*—As has been stated, the operation of blasting in this mine is performed by an officer called a "blasting overman," who does the blasting himself and never leaves it in charge of miners. When a charge is to be fired, the blasting overman is required to examine the air for gas. If the amount of gas found is below 1 per cent., he uses an ordinary fuse and dynamite, and ignites it with a joss stick. When the percentage of gas is over 1 or 1½ per cent. he uses an electrical blasting machine. If the content of gas is 2 per cent., blasting operations are rigorously prohibited, and if it rises above 3 per cent. communication is instantly cut off.

As these regulations were strictly in force in the mine, it is believed that the explosion did not originate from blasting operations.

At the point of origin of the explosion there was a hole 1½ feet deep and at the end of the right 16th level, one hole 1 foot 4 inches and another 1 foot 3 inches deep which had not been charged. Whenever blasting is to be done, all miners must retire to safety places at a proper distance; but here all the dead bodies of the miners were found at the working face, so it is evident there was no blasting; hence it is truly believed that this explosion was not caused by blasting.

5. *Bringing in Fire-Producing Materials.*—On the day of the explosion the inspection of the bodies of the miners at the mouth of the upcast shaft was conducted at 3 a. m., 4 a. m., and 6 a. m. The object of this examination of the body was to find matches, tobacco, tobacco pipes, tobacco pouches, dynamite, etc., which the miners might secrete about them. The method of examination consists of passing the hands over the clothes of miners, one by one, and if any one has in his possession a parcel or something in his pocket it is taken out and minutely examined. Though the bodies of all miners were examined in this way, no offender was discovered.

When a police officer examined the bodies of miners killed in the explosion, he inspected at the same time the belongings attached to the dead bodies. However, there has not yet been found any fire-producing material, such as matches, tobacco, etc., but an abundance of playing cards, dice, "cash," etc., for use in gambling.

Hence the inspection of miners' bodies which was daily performed at the mouth of the shaft by an officer of the colliery seems to be a formal business, and as he thought its practical effect to be comparatively small, I have carefully investigated the six miners at incline 7½ and the end of the 16th level with the result that it is known that two of these men were in the habit of smoking, while the others did not smoke. One of the two had been employed over a year and the other about 6 months.

Further, when I had reinspected incline 7½, I examined the place with great care but found no fire-producing materials, such as matches, tobacco, etc. The nearest smoking place to the working face of incline 7½, where the smokers worked, is at the right 9th level of New Kuroki incline, a distance of 2,100 feet. If the two miners were dishonest and deceitful and disliked to travel this distance they might have violated the regulation, but according to the careful investigation, both miners were honest and upright and always strictly observed the regulations of the mine. Hence, it seems that no miner carried in fire-producing materials such as matches. Again, according to the statement of the police officer who examined the belongings attached to the bodies of both miners, they had not carried matches, tobacco, etc. Hence the source of the fire in this explosion is believed not to be the carrying of matches underground.

6. *Safety Lamps.*—For the first shift of that day, December 15, 1914, the overman of safety lamps, F. Katsuki, delivered safety lamps, cleaned and tested according to the regulations, to all men who entered the mine in the following numbers: Wolf lamps, 37; Cambrian, 3; Clanny-Thomas lamps, 644; electrical lamps, 3; total, 687. Furthermore, according to an inquiry of the examiner of safety lamps, there were no violations in the procedure of delivering cleaned and tested lamps. The lamps of the miners working in incline 7½ and at the end of the right 16th level were found after great trouble and carefully examined with the following result:

Working Place	No. of Lamp	Result
Incline 7½	193	Glass cylinder and wire gauze perfect. Slight amount of coke dust adhering to the inside of the gauze.
Incline 7½	1,099	Glass broken. Coal dust and coke adhering to the inside of the gauze.
Incline 7½	581	Slight depression in the outer shell, otherwise perfect.
Right 16th level	254	Perfect. Shows no alteration.
Right 16th level	933	Glass cylinder perfect. Roof of gauze burned.
Right 16th level	645	Perfect. No change.

It is worthy of notice that a slight quantity of coke dust adhered to the inside of the gauze of the lamp No.

193, notwithstanding that the lamp itself, the glass cylinder and the gauze, were perfect, showing no change on the outside. After taking out the coke dust from the gauze and examining it under a microscope, it was clearly found that it was burned coke dust which entered the interior of the lamp with the gas in the form of fine coal dust and exploded in the inside of the lamp, changing the coal dust to coke and attaching it to the inner walls of the gauze.

Hence, the source of fire in the explosion seems to be the explosion of gas and fine coal dust in the inside of the lamp. Furthermore as a check, I examined many lamps from every part of the mine, selecting such as had a considerable amount of coke dust on the outside of the lamp, though the glass cylinder and gauze were perfect. On opening the lamps and examining the inside of the gauze, I could not find cohering coke dust on the inside of the lamp, which showed clearly that gas and coal dust had not exploded inside of these lamps. Among the many lamps, only lamp No. 193 has coke dust on the inside of gauze, therefore I have concluded more and more surely that the source of the fire in the explosion is the explosion of gas and coal dust in the inside of the lamp.

A letter from Mr. Meguro, dated May 16, states that the dip side of the mine is still so obstructed by roof falls and the gradual accumulation of mine water that its complete exploration has been impossible.

Simply because some trouble makers have been found among educated miners is no indication whatever that a majority or even a material percentage of educated miners are of such a class. The evidence is overwhelming that just the contrary is the case, and we find the large coal companies not only expending money to educate their men, but almost begging them to attend night schools.

Coal Fields of South America

The Coal Bearing Regions of Peru and Ecuador—Quality of the Coal—Importations

By Wilbur Greeley Burroughs

PERU has fifteen principal coal bearing areas. Of these the Department of Lima contains several important fields, the provinces of Parquin and Quiruragra in this Department having one of the largest and foremost coal fields in Peru, the estimated coal reserve of which is 720,000,000 tons.

On the east slope of the Andes in the Department of Junin are 1,200 square kilometers of coal formations, with coal running 50 to 60 per cent. carbon. The estimated tonnage is 600,000,000 tons.

Along the Pacific Coast, in the Department of Tumbes, occur coal deposits 450 square miles in area. The coal beds are exposed at tide level and also outcrop in the adjacent hills and ravines.

In the Department of La Libertad, province of Pacasmayo, there is a coal field extending from the coast to Cupisnique and Trinidad. At Cupisnique there is a seam of coal .6 meter thick. The analysis of this coal shows: Moisture and volatile matter, 17.5; fixed carbon, 76.5; ash, 6.

In the province of Santiago de Chuco the coal formations occur in a basin of 24 square kilometers, with beds 3 to 5 meters thick. In places these coal seams are said to be 8 and even 12 meters thick. The coal contains a high per cent. of fixed carbon. The district is 129 kilometers, from the port of Salaverry, via Motif.

The provinces of San Pedro and Otuzco contain coal beds, in Otuzco up to 6 meters thick. The coal averages 60 to 70 per cent., and as high as 90 per cent., fixed carbon. Near Huaiday is a bed of coal of very high quality, 1.5 meters thick, and a lower bed 2.3 meters thick. The coal reserve of this field is estimated at over 15,000,000 tons.

In the Department of Ancash, province of Cajatambo, is an important coal region. At Oyen the coal seam is over 8 meters thick. The deposits are 200 kilometers from the port of Huacho.

In the Department of Cajamarca coal occurs. A bed of anthracite, .75 meter thick containing 84 to 87 per cent. carbon, exists in Cajambamba province. In Chota province, 245 kilometers from the Pacific, four seams of anthracite are said to occur, ranging from 4 to 20 meters in thickness. The coal reserve is estimated at 700,000,000 tons.

Among the other Departments containing coal are Piura, Lambayeque, Huanuco, Huancavilica, and Ica; in the Andes and near the headwaters of the Amazon, the Departments of Amazonas, San Martin, and Loreto. There is also coal on the eastern slope of the Andes in Apurimac and Cuzco; as well as in Puno, north of Lake Titicaca; and Moquegua, and on the coast at Morro de Sama in the Department of Tacna.

Z. Borlkjof, quoted in "Coal Resources of the World," is authority for the foregoing statements.

The total coal reserve of Peru is estimated at 2,039 million tons of anthracite and bituminous coal.

Thus, it is seen that Peru contains a considerable coal reserve, but these coal fields are as yet but slightly developed. This being so, is there at present much chance of these Peruvian coals competing with coal imported into Peru from foreign countries? Concerning this subject Eduardo Higginson, Consul General of Peru, at New York City, stated to the writer that transportation facilities from the coal fields to the coast cities are as yet so poor and carrying rates so high that native coal cannot compete to any extent with foreign coal. But as the coal fields become developed and

transportation is made easier, the coal and other non-metallic and metallic mineral deposits will increase in importance and value. He considers that this is the time for Americans to grasp the opportunities awaiting them in Peru for he thinks that, as soon as the European war is over, Germany and England will endeavor to enter the field.

So until transportation facilities in Peru are greatly improved the importation of coal will continue. "The average price of coal at Callao," states U. S. Vice-Consul General Hamilton Jones in Special Consular Reports, No. 43, Pt. I., "is about $15 per ton of 2,000 pounds. Cardiff coal in 100-ton lots sometimes sells for $12 per ton. The stock usually carried in Callao-Lima, is about 10,000 tons."

The following statistics furnished the writer by Pan-American Union show distinctly the countries which up to now have led in supplying Peru with coal:

IMPORTS OF COAL INTO SOUTH AMERICA

Peru	1912	1913
Total values	$757,239	$1,466,227
Values by Countries:		
Australia	$ 80,242	$106,603
Belgium	12,070	38,259
Chile	70,732	77,933
France	23,458	
Germany	43,596	318,198
Netherlands	21,591	45,266
Great Britain	183,930	768,424
United States		

At least while the European war continues these figures will of necessity become greatly changed. It remains to be seen whether the United States can reap any advantage in this branch of our South American export field.

ECUADOR

Coal occurs in quantity in several places in Ecuador, especially in the province of Cañar, at Cojitambo, Mangán, and Biblián, where the coal is said to be of excellent quality. This region is not more than 50 miles south of the Guayaquil and Quito Railway, but due to lack of transportation facilities it has been impossible to develop this coal field with profit.

North of Quito, at San Antonio de Pomasqui, are beds of anthracite.

Coal is reported to have been found at Calacali, Latacunga, Rio Puncuyacu, and Nanegal.

But though coal is thus known to occur, there are no coal mines actually in operation in Ecuador. These statements are made on the authority of "Coal Resources of the World," and information furnished the writer by the Pan-American Union.

Since no coal is mined commercially in Ecuador, the supply has to be imported, the value of the importations and the countries from which the coal comes being shown in the following table:

Ecuador	1911
Total Importation	$107,930
Australia	$53,000
Germany	209
United States	54,000
Total tons, in 1912	32,486
Total tons, in 1913	30,891

"The largest consumers of coal," states U. S. Vice-Consul General Robert B. Jones, of Guayaquil, in Special Consular Report, Vol. 43, Pt. I, "are the Guayaquil and Quito Railway Co., and the Guayaquil Gas Co. Approximately 80 per cent. of the coal is steam coal and 20 per cent. gas coal. The quality is fair. The steam coal is delivered in lighters of the Guayaquil and Quito Railway Co., and the gas coal at the wharf of the gas company."

Care of Air Compressors

Air cylinders, receivers and pipes of an air compressor should be frequently cleaned of accumulated oil, deposited carbon, and organic dust. The air intake should be located where an abundant supply of pure, cool air may be obtained. If these precautions are not taken, there is danger of the production of carbon dioxide from the heated carbon deposits. This may suffocate miners if supplied to underground machines.

Mechanical Doors *vs.* Brick Doors, on Beehive Coke Ovens

Written for The Colliery Engineer

In THE COLLIERY ENGINEER for December, 1914, there appeared an article on "New Developments in Beehive and Rectangular Coke-Oven Equipment," in which attention was drawn to mechanical doors fitted for Campbell's plastic clay. It is the purpose to go somewhat into detail as to the saving effected by this type of door over the old style "bricked-up door" for beehive ovens.

It has been truly said that any kind of a mechanical door will effect a saving over the brick door, but it is the purpose to show the advantages of doors of the McMurray type, which are no longer a matter of experiment. The objection has been raised that they were too heavy and that the cast-iron fingers on the inside would burn off. These objections may be well founded. If so, Mr. E. C. Auld, construction engineer of the H. C. Frick Company, has overcome them, having designed and patented a much lighter cast-iron door with replaceable fingers. Indeed, it is now found that doors of not much more than half the weight of the original McMurray type will stand the wear and tear, and it is seriously considered to make them of light steel instead of cast iron. Furthermore, it has developed that the fingers do not have to be so close together if a good daubing mixture is used.

There seems to be no question but that the solid-back door with a solid one-piece lining, is the most economical to install and operate, and the door manufacturers are making them. The function of the lining material is to protect the door and prevent "hot spots." The Campbell plastic clay has been found to serve this purpose, even when applied as thin as 1¼ inches to 1½ inches. The old tile linings were 3 inches or 4 inches thick, and to make them any thinner is difficult for the brick manufacturer, especially if the other two dimensions are large.

Doors can be easily lined with the prepared clay, which is inexpensive and easily kept. In case it gets dry, a little water makes it plastic again and ready for application. A bucketful with a trowel will make the necessary repairs to several hundred ovens on a day's run. A careful record showed that repairs to the linings on 12 doors for a period of 4 months, cost $1.50, the damage being due chiefly to scraping the lining against the oven wall.

One thing that should commend the solid-back mechanical door to the beehive coke oven operator, is the saving in coke yield. Careful tests have shown that this saving amounts to from 100 pounds to 200 pounds of coke per oven. Table 1 shows a fair average over a considerable number of tests.

TABLE 1. TEST OF BRICK DOOR AND SOLID-BACK DOOR

	Brick Door		Solid-Back Door	
	Wet	Dry	Wet	Dry
	Pounds	Pounds	Pounds	Pounds
Coal charged	14,760	14,336	14,570	14,043
Coke drawn	9,942	9,434	10,010	9,492
Ash pile	463	437	390	366
Loss in burning	4,355	4,465	4,170	4,185
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Yield of coke	67.35	65.80	68.77	67.58
Yield of ashes	3.13	3.05	2.67	2.60
Volatile matter	29.52	31.15	28.56	29.82
Moisture in coal	2.87		3.62	
Moisture in coke	5.11		5.18	
Moisture in ashes	6.00		6.28	

In this yield test, on a dry basis, it will be noted that the solid-back door shows an increase of 1.78 per cent. coke over the "bricked-up" door. The ash pile from the mechanical door is 71 pounds smaller than in the brick door, which is a natural conclusion, since all air leaks are stopped by the solid back. It is safe to say that a saving of 1 per cent. in coke yield will be effected by the use of the solid-back door, which amounts to 100 pounds per oven on a 5-ton per oven basis. The coke stands high in the oven next to the door. As one progressive operator puts it, "It's no trouble at all to get a good wagon with the solid-back door."

The saving is further exemplified as follows:

ASSUMPTIONS

A 400-oven beehive plant equipped with solid-back doors and drawing 5 tons of coke from 200 ovens per day for 300 days per year, and showing a saving of 1 per cent. coke yield, with coke at $2 per ton.

THE SAVING

$200 \times 5 \times 300 \times 1\% \times \$2 = \$6{,}000$ annually.

The foregoing saving in coke yield is based on the conservative saving of 1 per cent., or 100 pounds per oven. The probabilities are that from 150 to 200 pounds of coke will be saved per oven over the "bricked-up" door, especially if the latter is poorly daubed and not watched. Good loam for daubing brick doors sometimes is not available on the plant, and the chances are that the coke operator has not figured out that it would pay to ship in A 1 loam for the purpose.

These operating difficulties are overcome by the use of the mechanical solid-back door with a daubing material prepared expressly for the purpose. Such an oven needs no watching to see if the holes in the daub are all stopped. Sometimes it is very difficult to see if they are all closed on a "bricked-up" door. The only sure way to detect air leaks is at night when the incandescence from the oven shows through the door.

In this discussion, the qualification is clearly made, that a saving in yield can be made only by the use of a solid-back door or by the use of a solid lining, which prevents air leaks through it, with the consequent "cutting out" of the coke in front and on top of the charge. Open-back mechanical doors with loosely fitting or cracked tile for the lining, are perhaps as bad as the old style "bricked-up" doors daubed with loam, if not worse, no matter how efficient they may be otherwise in effecting a saving in operating and material cost.

In installing mechanical coke-oven doors, the question of saving in coke yield is of prime importance. By-product coke-oven operators know the significance of air leaks. Why shouldn't beehive operators? A door may be admirably suited in first cost and that of operation, but it may show an insidious loss in coke yield. Lack of ashes is not always a criterion of a good coke yield, for loss in yield is sometimes deep seated, when aeration and temperature cause a loss of carbon that otherwise ought to go into coke. It is such losses that undermine the economies of the coking operation and change what otherwise would be a profit, into a disheartening loss in these days of a close margin of profit at the best. From this time forth, every 100 pounds of coke per oven is going to count, and the operator who gets it is most likely to remain in the beehive coking game the longest. At the best, the beehive process is a wasteful one.

The work of operating mechanical doors and bricked-up doors is shown in Table 2. The table shows

TABLE 2

	Brick Door Minutes	Mechanical Door Minutes
Putting up door	$3\frac{3}{4}$	$1\frac{1}{4}$
Leveling by hand	6	$5\frac{3}{8}$
Daubing	$2\frac{1}{4}$	$1\frac{1}{4}$
	12	$7\frac{7}{8}$

a total saving in time per oven of $4\frac{1}{8}$ minutes for the mechanical door, which, on a 200-ovens-per-day basis, amounts to 825 minutes, or $13\frac{3}{4}$ hours. With a good system of mechanical handling the saving in time is probably nearer 5 minutes per oven.

OPERATING CHARGES

One door complete with handling apparatus costs	$18.75
One lining of Campbell plastic clay	1.25
Total	$20.00
Cost for 400 ovens at $20 each	$8,000

[illegible]	Brick Door	Mechanical Door
Interest and depreciation on $8,000 at 25 per cent. per annum is		$2,000
240,000 door cubes at $15 per 1,000 (4 per oven per day)	$3,600	
Loam, 80 pounds, for brick door and 20 pounds for iron door	2,400	600
Loss in yield of coke at 1 per cent.	6,000	
	$12,000	$2,600

$\$12{,}000 - \$2{,}600 = \$9{,}400$, or a return of $117\frac{1}{2}$ per cent. on the investment of $8,000. In other words, the installation of mechanical solid-back

doors will pay for itself in less than 1 year.

In this estimate of savings, it is figured that the average life of a door and lining is 5 years. The door itself will probably last much longer. This high charge of 20 per cent. should cover all replacements and repairs to the lining in labor and material. New A 1 loam is figured at $1 per ton delivered. It probably is not possible to get away from the use of a little loam for luting the sides of the mechanical door, even though mechanical aerators at the top are employed. At present the air supply over the door is regulated as in the "bricked-up" door, which requires luting with loam. Labor is not shown in the estimate. It is assumed to be the same in each case.

A plant of the assumed size would produce $200 \times 5 \times 300 = 300,000$ tons annually, and the saving per ton of coke would be $9,400 \div 300,000 = \$.03$.

It is thus shown that the saving effected by the mechanical door is over 3 cents per ton of coke produced. One conservative operator using mechanical doors says it is easily 5 cents per ton, and a nickel a ton is a big item in the cost of coke. One can easily see how his statement is correct if the increase in yield should be 200 pounds of coke per oven instead of 100 pounds, as used in this article.

The plastic clay for lining doors of the McMurray type is manufactured by the Harbison-Walker Refractories Co., of Pittsburg, Pa. It is prepared especially for this work, so that there is but little shrinkage and no fire-cracks when daubed on in big areas. Furthermore, it has a special binder to hold it together.

The value of coal produced in Canada is 26 per cent. of total value of the mined products of that country. The mineral fuels altogether, including natural gas and petroleum with the coal, have a value of 29 per cent. of the total for mineral products.

Powdered Coal

*By W. L. Robinson**

The cost of fuel for the 65,000 steam locomotives in use in the United States will approximate from $250,000,000 to $275,000,000 per annum, and now represents about 25 per cent. of the total transportation account expenses.

The fuel used by the steam locomotives today is principally bituminous coal, and secondarily, anthracite, fuel oil, lignite, and coke, depending on the most readily available local supply at the lowest cost.

In some cases anthracite, coke, or fuel oil is used at relatively higher cost than that for the local fuel, due to legislative requirements, with respect to smoke, cinders, sparks, and fire restrictions.

The existing means for burning coal, lignite, and coke in locomotives is on grates, either hand or mechanically fired.

While powdered coal has been used successfully and rather extensively for many years in cement and metallurgical furnaces, its use for steam making purposes has been limited, due to the lack of practical development.

Coal in a finely divided or powdered state represents the most advanced method for producing perfect combustion, thereby making it possible to more nearly obtain the full heat value of the fuel than by any other known means. While a cubic inch of solid coal exposes only 6 square inches for absorption and liberation of heat, a cubic inch of powdered coal exposes from 20 to 25 square feet, which enables the more uniform gas production from the volatile matter in the coal and the more prompt and perfect intermingling of gas and air, thereby improving combustion and reducing smoke. Furthermore, there is no cooling of the fire by heavy intermittent charges of fresh coal, as is the case with hand or stoker firing on grates, and consequent production of lost heat.

These advantages from the use of powdered coal have long been recognized by mechanical engineers, and utilized with the result of obtained fuel economies running as high as 50 per cent. in metallurgical work.

While mechanical undercutting and shearing of coal prior to blasting is the process followed in the mining of approximately one-half of the total coal produced, the practice of "shooting off the solid" still prevails, particularly where the payment for mining is on the "mine-run" rather than on the "screened" basis. The grade of the output is therefore reduced by the larger proportion of fine coal, and by the lump coal being so friable as to disintegrate rapidly through transportation and handling.

Therefore the mechanical production of coal has materially affected the grade of coal produced, by increasing the percentage of dust and slack which in some instances is as high as from 45 to 55 per cent. of the total mine output.

The generally recognized waste, unsalable or otherwise low-value coal mine products, such as culm, slack, mine sweepings, and dust, all of which are suitable for converting into powdered form, represent practically the same acreage and mining cost per ton as the commercial grades. Moreover, by powder mining and mechanically excavating coal in a fine state suitable for powdering, out of shallow, faulty, and otherwise undesirable or abandoned operations, much fuel that is now going to waste could be advantageously mined and utilized.

Furthermore the annually increasing expense to produce the inferior coal, due to the timbering of underground roadways to make accessible the more remote workings; pumping of water out of active as well as dead sections; furnishing air to live as well as unprofitable sections to prevent the formation of gases; pumping refuse into mines for surface protection; increased initial development cost preparatory to taking out coal; and generally higher costs due to improved means

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and methods for mining and for the greater security of labor so employed, now make it essential that the railways utilize all possible of the inferior grades and qualities of local fuel supply, in order to conserve the better mine output for commercial revenue tonnage in the domestic and foreign trade.

It has generally been thought that for the burning of solid fuels in powdered form in suspension, a bituminous coal of less than 30 per cent. volatile matter could not be used with satisfactory results.

As the object is to convert the powdered fuel into a gaseous state as early during the process of combustion as practicable, this characteristic as regards the desired proportion of volatile matter, while desirable, has not been found to be essential. Your reporter has been informed that satisfactory results are now being obtained in locomotive practice from semibituminous coals analyzing as low as 21 per cent. volatile and having 15 per cent. ash and moisture, which is powdered so that about 65 per cent. passes through a 200-mesh, and 95 per cent. through a 100-mesh screen.

In general, powdered coal, to give the best results, that is, complete combustion and the least trouble with ash and slag, should contain not more than 1 per cent. moisture, and be of a uniform fineness, so that not less than 95 per cent. will pass through a 100-mesh, and not less than 85 per cent. through a 200-mesh, and not less than 70 per cent. through a 300-mesh screen.

As to the need for drying coal by artificial heat before grinding it, or when burning it, this is an item of cost that cannot be eliminated, regardless of whether coal is burned on grates or in suspension. When undried coal is fed into the furnace, the moisture (both free and combined) is evaporated in the furnace itself, which means an added quantity of coal to maintain the temperature, which is reduced about 72° F. for each 1 per cent. of moisture entrained. As this cannot be overcome by feeding additional fuel with the same percentage of moisture, the loss of heat is about double this for each 1 per cent. of moisture, which percentage of loss is further increased when applied to the usable heat above the temperature of the escaping smoke box gases. However, by drying the coal before grinding, the cost for the former will be almost saved in the decreased power necessary for pulverization and in the improved combustion resulting from the greater degree of fineness of the artificially dried as compared with the moist coal. Moreover, the dry coal will readily flow and give less trouble through tendency to pack, clog, and adhere during the process of grinding, conveying, storage, and combustion.

With respect to the need for grinding the coal to the fineness specified, while this is not necessary in order to effect its combustion, it is most advisable, inasmuch as the greater degree of and uniformity in fineness, the greater the assurance that every particle will burn instantaneously when suspended in its air supply. This will require that a suitable storage, crushing, drying, grinding, and conveying plant be installed.

With regard to the cost for preparing powdered coal, this will vary with the cost for the raw coal and its moisture content. However, a general average from available data covering periods of the past 5 to 10 years at cement and metallurgical plants will enable the following conservative estimate, assuming the cost of the raw coal at from $1 to $2 per short ton, and that it will require crushing and have a moisture content of from 5 to 10 per cent., when placed in the dryer.

Capacity of Plant in Short Tons Per Hour	Average Total Cost for Preparation Per Short Ton
2	From 25 to 50 cents
3	From 2[illegible] to 45 cents
4	From 1[illegible] to [illegible]0 cents
5	From 14 to 35 cents
10	From 12 to 30 cents
25	From 10 to 20 cents

The fuel required for drying the coal will average from 1 to 2 per cent. of the coal dried.

The distribution of the total cost may be approximately stated as:

	Per Cent.
Fuel for drying	10
Power for operation	30
Labor	30
Maintenance and supplies	25
Interest, taxes, insurance, and depreciation	5
Total	100

The cost for preparing powdered coal should be more than offset by the ability to utilize mine refuse and sweepings, run-of-mine, screenings and slack, grades of coal that cannot be utilized to good advantage otherwise, and inferior grades of subbituminous coals, lignite, and peat of relatively lower cost per ton than the more readily salable commercial fuels.

Coal dust was first mentioned as a dangerous element in England at the beginning of the Nineteenth Century. Since that time, France, Germany, Belgium, and the United States have all actively investigated its characteristics.

In general, any organic dust of certain fineness, suspension, and temperature, is explosive, as it has an affinity for oxygen, as for example, the inflammable dust in grain, soap, sugar, planing, and other mills. In fact, almost any organic combustible material may be considered as explosive under certain conditions of fineness, suspension, expansion, and inflammability, although high velocity of air-current is unfavorable to ignition. Large particles of dust burn comparatively slowly and cannot produce an explosion, because the period required for their complete combustion is too long. However, very fine dust suspended in nearly still air may produce an explosion, because the area of its surface and the volume of the volatile matter disengaged are much larger in proportion to its contents than the large particles, and the air and volatile matter are more intimately mixed when ignition occurs.

Finely divided coal dust gives off gas at normal atmospheric temperature, but any pulverized coal coarser than that which will pass through a number 100-mesh screen is liable to explosion only when distilled by the heat or compression of a pri-

mary ignition. The finer than what will pass through a number 100-mesh screen carries no danger unless combined in a dry state, in floating suspension in nearly still air and mixed with the requisite amount of oxygen at the requisite temperature to produce "chemical tension" or primary ignition.

Powdered coal may be burned by either of two generally defined methods:

The first, or long-flame method, constitutes a progressive burning of the coal, and is used in cement and other stationary or open-hearth furnaces, when the character of the latter or of the work, or both, is such that an elongated flame may be developed and continued well through the furnace. This combustion is accomplished by projecting the primary air which carries the fuel into the furnace with high velocity, the additional air (about 75 per cent.) required for combustion being blown or induced into the furnace from other sources.

The second, or short-flame method, has been the latest development, and is used in metallurgical and similar metal heating work, and under boilers where a similar furnace volume obtains and the least cutting action upon the brick work is essential. This process involves a flame of relatively short travel, and consists of admitting the entire air supply needed for combustion into the furnace with the fuel at low velocity.

Your reporter has been given to understand that in the application of powdered coal to a New York Central locomotive, a combination of the long- and short-flame methods has been used.

The Disappearing Culm Piles

The magazine writers' mountains of culm are gradually disappearing, at least in the vicinity of Scranton and Wilkes-Barre.

A Disappearing Culm Pile. It Once Covered All the Ground Here

The chief cause for their disappearance is depicted on the cover of the April Colliery Engineer, namely, by hydraulic mining. The culm bank is washed down by a stream of water which carries it also to a trough. If the trough is inclined the material flows by gravity to the elevator boot of the washery. If the culm is in a position where it cannot flow, long scraper lines working in a trough carry it to the washery. The fine material discharged from the washery is allowed to flow through pipes into the mines, where it fills up excavations and makes it possible to take out coal pillars. This is known as culm flushing. Another cause for the disappearance is that small coal once thrown on the bank as culm is now saved and marketed; the material, which is fairly good coal but not marketable, is used by the operators for steam purposes; finally, material that is too dirty for use is flushed into the mine direct from the breaker, and none accumulates on the surface.

Many culm piles have been burned and many others are on fire. Most of these fires were due to the spontaneous ignition of the culm, a fact which has been the cause for the advancement of many original theories on spontaneous ignition. It is generally accepted that spontaneous ignition is due to the coal heating gradually by oxidation. Using this as a starting point, the theorists have given the cause as the oxidation of fine coal, of pyrite, decay of timbers, oily waste thrown as refuse among the culm, and finally dead mules.

Each one of the theories advanced is possible and it may be that alone or in combination these things originated the fires.

One writer states that the most prolific cause of spontaneous combustion was fallen timbers and brush covered by culm piles, and dirty oily waste thrown as refuse among the culm. Anthracite companies now clear all timber and brush from areas where they store coal or make culm piles.

Another writer states that "it formerly was the practice when a mule died to simply dump it on the pile and cover it over with the culm that was unloaded on the dump. Decomposition took place heating the carcass. That increased the rate of decomposition, which further raised the degree to which the carcass was heated, until finally there was sufficient temperature to set the carcass on fire and so ignited the culm pile."

This theory is chemically correct, but who ever saw a dead mule?

Timber in Coal Mines

The amount of timber used in anthracite mines is approximately 1 cubic foot per ton of coal mined. The bituminous coal mines in Pennsylvania use about ½ cubic foot, and all bituminous coal mines about ⅓ cubic foot per ton of coal mined. The cost is about 6.5 cents per cubic foot for round timber and 20 cents per cubic foot for sawed timber.

The Harlan, Ky., Coal Field

General Description of the Field, Its Drainage, Topography, Mineral Resources and Development

By W. R. Peck*

THE purpose of this paper is to give a general description of this new coal field, which has become of great importance in the last few years; its drainage, its topography, its mineral resources and their development.

The information for this paper has been secured from many different sources, besides that obtained in professional services for different corporations and individuals in the last 10 years. Professional paper No. 49 of the United States Geological Survey and Bulletin No. 12 of the Kentucky Geological Survey have been consulted, as have several individuals interested in this field.

The Harlan coal field is in Harlan County, Ky., and is the eastern part of the Cumberland Gap coal field. It is separated from the railroads of Virginia, constructed some 25 years ago, by the Cumberland, or Stone, and the Little Black Mountains. At the foot of the southern slope of the Cumberland Mountain is the Cumberland Valley Division of the Louisville & Nashville Railroad; while at the base of the Little Black Mountain is found the Virginia & Southwestern Railroad, a branch of the Southern Railway. The two mountains mentioned above, form an almost impassable barrier between these railroads and this coal field. On the northern side of this field, we find the long straight crest of the Pine Mountain effectually blocking this field from any railroad from that direction. These two barriers forced the railroad entering this field to follow the route that nature picked centuries ago for her drainage, that is to follow the many winds of the Cumberland River.

Topography.—This coal field is one of high steep mountains with numerous spurs, with narrow valleys along the streams. However, the main streams will all permit of railroad construction at a very reasonable figure, and also give room for the necessary mining plants and their villages.

The mountains, rising from 2,000 to 2,300 feet above the valleys, expose a great thickness of coal measures that carry several beds available for cheap drift mining.

The Big Black Mountain, the highest in the field and almost impassable, extends from Harlan Town to the State Line Spur at the head of the Poor Fork of the Cumberland River, a distance of approximately 50 miles. This mountain is the backbone of the coal field. It is crossed by one wagon road, opened many years ago when all the supplies for this field as well as many for the Kentucky River section were wagoned from Lynchburg, Va., and other railroad points in that state. This is the road from Stonega, Va., to Whitesburg. A few bridle paths cross the Big Black at different points.

The Little Black Mountain extends from Harlan Town, about 52 miles to the Double, its junction with the Big Black Mountain, near Keokee, Va. The elevation of the mountain here is 4,100 feet above sea level. Although high and rugged from Harlan to near the head of Clover Fork, it drops until at Morris Gap the wagon road to Virginia crosses the mountain with a very easy climb.

The Martin's Fork Ridge, and main spurs, extends from near Harlan in a southwest direction to the head of Martin's Fork, in Bell County, Ky., a distance of some 18 miles. It has several leading ridges of several miles in length. It is crossed by one wagon road and by several bridle paths.

The Cumberland Mountain extends from the head of Cranks Creek into Tennessee, and although crossed in two places by a wagon road and several paths, yet it is almost an impregnable barrier.

The Pine Mountain, although crossed by several wagon roads, will for some time bar any other connection between the Harlan coal field and that of the Kentucky River.

The map of this coal field has upon it several elevations and they will give a general idea of its topography. It will also give the main drainage of the field, which is the three forks of the Cumberland River, which unite near Harlan to form the river proper. Poor Fork follows the base of the Pine and Big Black Mountains; Clover Fork drains the watershed between the Big and Little Black Mountains; Martin's Fork and its many tributaries drain the territory between the Little Black and Stone Mountains and the Martin's Fork Ridge.

Geology.—The geological structure of this coal field is that of a flat-bottomed syncline with its axis almost parallel to the Cumberland River and Poor Fork. From this axis the rocks rise with slight grades, until they are sharply upturned in the Pine Mountain by the Pine Mountain Fault, and in the Cumberland Mountain by the Powell's Valley Anticline.

The outcropping rocks in the mountains of the field are sandstones, shales, clays and coal beds. At several points, high in the moun-

*Consulting engineer, Big Stone Gap, Va. Paper presented at the annual meeting of the Kentucky Mining Institute, Pineville, May 14, 1915.

tains, has been found an impure limestone bed, about a foot in thickness and remarkable for the abundance of its fossils. The same limestone stratum is reported as having been located at only one point in the Wise County coal fields of Virginia, on the Pot Camp Fork of the Roaring Fork of Powell's River, but here it is more of a sandstone than a limestone.

The shales and sandstones are about equally developed, the sandstones probably predominating. The lower third is mainly sandstone, and in the upper two-thirds, sandstone beds are plentiful, averaging from 20 to 100 feet in thickness. The lower part of the section is not only principally sandstone, but contains some fairly coarse conglomerates; it contains little coal in this field and is below drainage or upturned at sharp angles in the enflanking mountains.

The United States Geological Survey states that a study of the fossils found indicates that all the rocks of this basin are of the age of the Pottsville Group of Pennsylvania. The formation in the lower part of the section is known as the Lee conglomerate. Above this conglomerate occurs about 2,300 feet of the Pottsville formation, as the highest rocks in the Big Black are at its top. In all, this formation is about 4,000 feet in thickness.

To properly lay out mines, it is necessary that the direction and magnitude of the inclinations of the beds and the location of the major lines of elevation and depression be known. Other conditions permitting, a mine should enter the coal bed at its lowest point, thus allowing the grades to be in favor of the loaded cars and drainage by gravity. Because of the gentle and gradual dip of the strata in this field and the fact that the main coal beds lie above drainage, many favorable locations present themselves for inexpensive drift mining.

Coals.—In the 2,000 and more feet of exposed strata between the foot and the top of the Big and Little Black Mountains and the Martin's Fork Ridge will be found more than a score of coal seams, of which half may have commercial value in individual parts of the field. Commencing with the lowest, they will be discussed in ascending order, using the name by which they are locally known and correlating them with the seams of the adjoining coal fields.

There are coal seams known to occur in the Lee Conglomerate, but they are generally believed to be worthless in this field. In the several hundred feet of strata between the Lee Conglomerate and the Harlan coal bed, no coals of importance are known, although on Martin's Fork and in one or two other localities a seam of from 2 to 3 feet in thickness has been found. The absence of a workable seam in this interval is of great interest, as it shows that the famous Imboden seam of Wise County, Va., has deteriorated and either disappeared or become insignificant here.

Coal Beds With Interval

Section Ascending

(Note.—This is an average section, and therefore in some parts of the field the interval will vary from the one given here.)

Coal Bed	*Thickness in Feet*
Lee conglomerate, base	
Hance formation	630
Mingo:	
Harlan coal seam	4 to 6
Interval	120 to 160
Leonard coal seam	3 to 5
Interval	5 to 60
Kellioka coal seam	2.5 to 7
Catron:	
Interval	20 to 40
McKnight coal seam	3 to 4
Interval	180 to 230
Low splint coal seam	3 to 3.5
Interval	400
Dean or Wallins coal seam	3.5 to 9
Interval	200
Limestone coal seam	3.5 to 6.5
Hignite:	
Interval	200 to 250
Cornett coal seam	3 to 7
Interval	40 to 80
High splint coal seam	4 to 9
Interval	500 to 700
Top of the Big Black Mountain.	

The Harlan Seam.—The Harlan coal bed is the lowest of the present workable seams of this field and is undoubtedly the one of most value. It outcrops from 400 to 500 feet above drainage on the Big and Little Black Mountains and the Martin's Fork Ridge near Harlan, and yet carries from 1,000 to 1,500 feet of cover and underlies large areas in each of the three mountains and their numerous spurs.

In the western part of the field the Harlan coal bed has not been opened and prospected as it has been around and above Harlan. In this district (the area drained by the waters of Forresters, Wallins, and Ewing creeks), it will very probably be found to be the most valuable coal when sufficient prospecting has been done to prove it properly. On Ewing Creek it is now being mined by one company and here shows a clean section of 33 inches. Also near this mine and some 200 feet under the Harlan is found a 36-inch seam of practically clean coal. The 36-inch coal has been opened in only two places, but appears to be regular and is very probably the same seam reported from openings on Martin's Fork. A thorough investigation may prove it to be of value in certain parts of this coal field.

At the junction of Clover and Martin's Fork, in the Big and Little Black Mountains and in the Catron and Ewing Spurs of the Martin's Fork Ridge, is found the best development of this coal bed. Here it maintains an average thickness of 4 feet of clean coal, and is being mined by 12 companies.

Passing eastward up Clover Fork, this coal bed maintains a good mining section until Yocum Creek is reached, where the only opening made on the seam shows it to be seriously contaminated by shale partings, but as only one opening exists on this side of Yocum Creek, and the many openings made between Jones Creek and Yocum show a good mining section, it is believed that the opening showing the shale partings is an abnormal one and that eventually it will be proved that the bed is of great value in this vicinity. In Virginia, across the Little Black Mountain from the head of Yocum Creek, this coal bed shows a thickness of 3 feet 6 inches of clean coal, and is known as the No. 3 seam of the Pocket Field of Lee County, Va.

This coal bed goes under drainage on Clover Fork about 14 miles above Harlan, just below the mouth of Seagraves Creek, and at this point it presents a clean mining sec-

tion of 3 feet 6 inches. From here, eastwardly, it rises with the stream and is never far below the water level, a few feet at Fugitt Creek and approximately 120 feet at the mouth of the Left Fork of Clover Fork, near the Morris Gap.

At Keokee, on the Virginia side of the Little Black Mountain, this bed is mined as the Wilson seam and shows 7 feet of coal with 15 inches of shale about 1 foot from the floor.

Along Poor Fork, below the mouth of Big Looney Creek it presents a mining section of from 4 to 5 feet, even reaching a thickness of 12 feet in places, but the upper portion of this great thickness is usually worthless, because of many slaty partings. Above the mouth of Big Looney it is split into two benches, neither of which is valuable.

On Martin's Fork and its tributaries this coal bed has been opened in many places, as it produces most of the fuel used by the citizens in this section. These openings show that the seam maintains an average thickness of a little less than 4 feet, although in many places a greater thickness has been found. The sections shown of the seam in this district are not as free from impurities, such as slate partings, as is the coal bed on Clover Fork, but nevertheless this coal bed will be a very valuable one in this district.

The chief characteristics of this coal bed are the same as those of the main coals of this entire coal field. The Kentucky Geological Survey describes it very well in the following statement: "A bright, pitch-black coal, fracture generally cuboidal and irregular; very little fibrous coal apparent but some granular pyrites."

This coal is hard, lumpy and of the block type, similar to those of the Kentucky River and the Elkhorn coal fields. It has marked vertical cleavages and mines in large, smooth-faced blocks, very different from the softer coals of the Virginia and West Virginia coal fields. It is well adapted to shipment and for domestic use.

It is high in volatile hydrocarbons; low in the harmful ingredient, sulphur, and exceptionally free from earthy impurities. As a domestic and steam coal it should rank high, as its hardness, ease of ignition, low ash, low sulphur, high B. T. U., and the fact that it will not clinker unless mixed with a considerable amount of impurities, will commend it to all consumers.

Analyses of the Harlan Seam

Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B. T. U. Per Pound of Coal
2.60	32.71	58.47	6.22		13,904
2.32	34.98	57.99	4.71		14,038
1.56	37.95	58.44	2.05	.69	14,600
1.40	36.39	56.86	5.35	.69	14,152
1.79	38.70	57.45	2.06	.42	15,389

Leonard, Kellioka and Upper Seams. The Léonard coal bed, so named by the Kentucky Geological Survey because of its development about Leonard Post Office on Clover Fork, near the mouth of Child's Creek, lies 120 to 150 feet above the Harlan.

On Clover Fork, this bed is first recognized on Yocum Creek, showing a 3-foot clean section. Going on up Clover Fork, the bed increases in thickness, but also carries some slate partings. At Child's Creek it shows a good mining section, but from here toward the head of Clover Fork it shows only a thin worthless section, or one that is badly ribbed with partings.

On Clover Lick and Big Looney creeks of Poor Fork it shows a varying section, but in Benham Spur 3 feet 6 inches of clean coal is found. On Martin's Fork this bed is reported, usually from 50 to 80 feet above the Harlan, and of 3 feet in thickness. This bed is the No. 4 seam of the Pocket Field, and there shows a thickness of 30 inches. It has the following analysis: (Average of 16 samples.) Moisture, 3.32; volatile matter, 38.72; fixed carbon, 57.95; ash, 3.33; sulphur, .65.

The Kellioka coal bed occurs approximately 30 feet above the Leonard. It is found throughout this field as well as in the fields of Wise and Lee counties, Va.

In the western part of the coal field under discussion it presents, as a rule, a small minable bottom bench, but the upper part of the seam is ribbed with slate partings. Because of the small number of openings, its value in this district is not known at present.

Around Harlan it is found high in the mountains, and is thought to be either too thin or badly ribbed with slate partings to be of much value. However, passing on up Clover Fork a 3-foot 6-inch minable section is shown on Jones Creek. Between Bailey and Seagraves creeks it again shows a thin section. At Child's Creek it shows 3 feet of clean coal. It is mined at Darby, across the mountain, showing from 2 feet 6 inches to 3 feet 6 inches of clean coal.

Above Child's Creek this coal bed increases in thickness, in many places showing over 4 feet of workable coal, and reaching a maximum of 4 feet 6 inches to 5 feet on the Razor Fork. At Keokee the coal mined runs from 5 to 7 feet with a 2- to 4-inch parting which increases to the east. It shows 4 feet 6 inches of clean coal on Little Looney Creek, Va., and is mined at Roda, Va., as the Taggart seam, with a thickness of 6 feet, but in some places is seriously contaminated with a parting near the center.

This bed reaches its maximum development in the Poor Fork district in Benham Spur and Looney Ridge, where it maintains an average mining section throughout this area of 5 feet 6 inches in thickness and is practically without a parting. In the Martin's Fork district this seam has not been opened to any great extent, but the mining section is from 3 feet to 4 feet 6 inches. Following is the analysis: (Average of 17 samples.) Moisture, 3.42; volatile matter, 38.79; fixed carbon, 58.92; ash, 2.29; sulphur, .65; B. T. U. per pound of coal, 14,554.

The McKnight coal bed lies about 50 feet above the Kellioka and reaches a workable thickness only in Looney Ridge and Benham Spur, where it shows an average of 3 feet

6 inches of clean coal and will be of some commercial value in the large area of these two mountains.

The Low Splint coal bed is the middle seam of a group of three seams covering a vertical distance of 120 feet, the lowest of which is 130 feet above the Kellioka. The thickness of this seam, the Low Splint, is about 3 to 4 feet with a little parting in some sections, and again showing only 2 feet 6 inches. Because of the thinness of the other two seams they will not be described.

The Wallins Coal Bed.—The Wallins coal bed is the Dean coal of the Kentucky Geological Survey, but it is generally known through this field as the Wallins coal. It is the fireclay coal of the Kentucky River field, the No. 7 of the Pocket field of Lee County, Va.

This bed reaches its maximum thickness in the Wallins Creek section of the field, presenting a 9-foot section with a 6-inch parting 18 inches from the bottom, leaving a top bench of 7 feet of practically clean coal. Lying high in the mountain, it has been sparingly prospected, but one is safe in assuming that there is a large workable area of this seam in the Reynolds and Potato Hill Ridges.

In the Harlan district it has been opened in the Little Black Mountain in Kitts Branch, showing an upper bench of 4 feet 4 inches of coal with a 6-inch shale parting 8 inches from the floor and a lower coal bench of 1 foot 2 inches, separated from the upper by 1 foot 4 inches of shale, coal, and bone. It has been exposed on Turtle Creek, presenting a workable section.

Going to the east up Clover Fork, it shows sections in the Little Rock Mountain of from 3 feet to 3 feet 6 inches of coal, but at all points has one or two partings which lessen or destroy its value. In the Big Black Mountain it has not been exposed with a workable section.

In the Grays Knob of the Martin's Fork Ridge it is found with a mining section that will compare very favorably with the one on Wallins Creek. The few openings made in the Martin's Fork Ridge show that as a rule this bed is found with a good mining section. The following is the analysis: Moisture, 4.004; volatile matter, 36.176; fixed carbon, 53.611; ash, 5.590; sulphur, .619.

The Limestone Coal Bed.—This bed derives its name from its proximity to the fossil limestone, some 50 to 100 feet above. This doubtless is the Smith 11- to 13-foot coal on Grays Knob and at the head of Pucketts Creek. It is very probably the No. 10 of the Pocket Field, and the Parsons of the Wise County Field.

In the high knobs of the Little Black Mountain, at the heads of Yocum and Childs creeks of Clover Fork and Straight Creek of Powells River, the seam shows from 4 to 5 feet 6 inches of coal in many of its openings, although usually parted with a little slate. In the Big Black Mountain it is usually thin and worthless. In Looney Ridge it presents a 5-foot section. This seam will be of value in small limited areas.

The Cornett Coal Bed.—The Cornett coal bed takes its name from the owner on whose land it was found. It is next to the bottom of a group of 4 or 5 beds all of which show a thickness of about 3 feet of coal, but because of their height above the valleys, the Cornett and the upper one only will ever be of commercial value. The bed lies about 200 feet above the fossil limestone, and varies in thickness from 3 feet 6 inches of clean coal to 7 feet with partings.

The High Splint Bed.—The High Splint bed lies so high that it overreaches the most of the Little Black Mountain, although there is considerable area between Jones and Days Creek of Clover Fork, where it shows a thickness of from 5 to 6 feet. Throughout the field this seam has been sparingly opened, but it shows a thickness of from 5 to 9 feet.

Besides the coal beds mentioned, there are numerous small seams occurring throughout the section, varying from a few inches to 3 feet in thickness, but all of doubtful utility. As may be noted from accompanying analyses, all the coals of this field are typical gas coals in chemical composition, comparing very favorably with the Pennsylvania gas coal. As domestic and steam fuels they should and do rank high. They are good coking coals, as has been proven by the coke of Keokee and Roda in Virginia, and Benham, Kentucky.

All the coal beds show two varieties of coal quite different physically, in varying proportions throughout the field. One is a hard, dull gray splint that occurs in layers of from less than an inch to a foot or more. The other is a softer, black, lustrous variety; it mines easier than the splint, is less difficult to crush and is more typically a coking coal.

History of Development.—For several years companies and individuals have been acquiring lands in Harlan County. But no successful attempt was made to build a railroad until the latter part of 1908, when Mr. T. J. Asher began the construction of 13 miles up Cumberland River from Wasioto on the Cumberland Valley Division of the Louisville & Nashville Railroad to two plants which he was installing on his properties in Bell County.

This was known as the Wasioto & Black Mountain Railroad and the Louisville & Nashville Railroad took it over and completed the road to Benham; then a branch was constructed up Clover Fork to Ages. This branch was put into operation August 3, 1912. In the summer of 1913 a branch line of 3 miles was built up Martin's Fork and put into operation that winter.

As soon as it was known that the railroad would be completed to these different points, several operating companies were organized. The first to begin shipping coal was the Terry's Fork Coal Co., now the Wallins Creek Coal Co., which is located on Terry's Fork of Wallins Creek, and about 1 mile from the

station of Wallins. This company is mining the Wallins seam, having a mining section here of 5 feet 10 inches. The daily output is 700 tons; the tipple is equipped with shaker screens, and four grades of coal can be made; the incline is about 6,000 feet long, the upper part being a gravity plane and the lower an engine plane.

On Ewing Creek, about a mile from the river, is the plant of Moss & Son Coal Co., formerly the Wilhoit Coal Co., operating on the Harlan seam, which has a clean mining section of 33 inches. This plant commenced to ship coal in the winter of 1911. The daily output is 300 tons; the tipple has shaker screens and four grades of coal can be made; a gravity incline is used to put the coal on the tipple. They operate their own power house, using both motor and mule haulage, and undercut the coal.

At Harlan, on Clover Fork, is the Republic Coal Co., formerly the Harlan Home Coal Co., operating on the Harlan seam in the Little Black Mountain. The Harlan seam here has a mining section of 4 feet 6 inches of coal with a 4-inch parting 1 foot from the bottom. This mine did not ship any coal until late in 1914, and now has a daily capacity of 150 tons. The tipple has shaker screens; the coal is brought to the tipple by a wire-rope tramway. Mule haulage is used, but power is purchased from central power station for cutting, etc.

On Clover Fork, about 1 mile from Harlan, is the mine of the Harlan Gas Coal Co., formerly the Harlan Town Coal Co. The first shipment of coal was made July 7, 1912.

The mine is in the Little Black Mountain on the Harlan seam which here has a thickness of about 4 feet or more. The tipple is equipped with shaker screens, and numerous grades of coal may be shipped; a gravity incline is in use; the output is 1,000 tons and upwards per day; the company owns and operates its own power house, using the power for cutting and haulage.

Near the mouth of Kitts Creek, on the south side of Clover Fork, is located the Clover Fork Mining Co. This operation was started about the same time as the Harlan Gas Coal Co. This mine is on the Harlan seam, which at this point has 50 inches of clean coal. The coal is delivered to the tipple by a gravity incline; the tipple has shaker screens; the output is about 800 tons daily; power is purchased for haulage, cutting, etc., from a central power station.

On the north side of Clover Fork at this point is the mine of the Rex Coal Co., formerly the Lynn Hollow Coal Co. This company is mining in the Big Black Mountain on the Harlan seam, which has a thickness of 3 feet of clean coal. The output is about 200 tons per day; a gravity incline connects the tipple and mine; the tipple has bar screens; mules are used for haulage and compressed air punchers for the undercutting of the coal.

On the Big Black Mountain, about a mile above the Rex Coal Co., is the mine and plant of the Golden Ash Coal Co. The Harlan seam is being mined with a thickness of 3 feet of clean coal. The daily output is about 300 tons per day; the mine was started in the spring of 1914. A gravity incline is used to put the coal on the tipple, which is equipped with shaker screens. At present, mule haulage is used and the coal is mined by pick and on the solid, but it is understood that electricity will be put in and power purchased from the central power plant.

The Wallins Creek Coal Co., mentioned above, has a mine on Clover Fork also, and here mines the Harlan seam on the Big Black Mountain side. The company started to ship coal in the winter of 1913. The seam mined is 3 feet of clean coal. A gravity incline lowers the coal to the tipple, which is equipped with shaker screens. The output is about 300 tons per day. Electric power is purchased for operating coal cutting machines and for haulage.

Some distance above this mine will be found the two operations of the Lick Branch Coal Co., Coxton mine on the Little Black side, and Kayu on the Big Black Mountain. Both mines, which were installed by the Harlan Coal Mining Co., are on Harlan seam, which at Coxton is 50 and sometimes as high as 54 inches thick; at the Kayu mine it is about 48 inches, both clean sections. The coal is lowered to the tipple at both mines by disk retarding conveyers. In addition to the retarding conveyer at the Coxton mine a belt is used to put the coal at the proper height for the shaker screens. Marcus screens and a loading boom are in use on the Kayu tipple. Electric power is purchased from the central power station and used throughout both mines. The combined output is from 1,200 to 1,300 tons per day.

At the end of the present branch line of railroad, on the north side of Clover Fork, is the mine of the Ages Ridge Coal Co. The Harlan seam in this mine presents a mining section of about 4 feet of clean coal. The daily output is about 300 tons. A gravity incline and shaker screens are used. Mules are used for haulage and the coal is worked by pick mining and on the solid.

On Catrons Creek of Clover Fork are located the two mines of the Catrons Creek Coal Co. The Harlan seam here is 4 feet of clean coal. The coal is lowered from two mountain sides to one tipple which has shaker screens. The daily output is about 1,000 tons. Mule haulage is used and the coal is shot from the solid.

The R. C. Tway Coal Co., formerly the Pineville Coal Mining Co., is located on the east side of Martin's Fork about 3 miles from Harlan. This company is mining the Harlan seam which here has the total thickness of 5 feet 8 inches, with an 8-inch parting 2 feet from the bottom or nearly 5 feet of coal. A gravity incline is used to lower the coal to the tipple, which is equipped with shaker screens. Mule haulage and pick mining is used. The output is about 500 tons per day.

The Looney Creek Coal Co. is located on the north side of Looney Creek, mining the Kellioka seam in Looney Ridge. This seam here has a thickness of about 6 feet. The present daily output is 250 tons, but this year will see it increased to 600 tons. A gravity incline is used to put the coal on the tipple, which is equipped with shaker screens; the coal is undercut, and mule haulage is used; the company has its own power house.

About 3 miles up Looney Creek from Poor Fork is located the plant of the Wisconsin Steel Co., at Benham, which is at present the end of the railroad up Poor Fork. To give a good description of this plant would take up too much time and only a few of the essentials of interest will be mentioned here. This plant was started in 1910 and was nearing completion when the railroad was finished. The Kellioka and the McKnight coal beds are both worked at this plant. There are 408 coke ovens and coke, steam and domestic coal are shipped. The coal is conveyed by a retarding conveyer at the mine on the Kellioka seam, and that part of the "D" or McKnight seam that is used in the ovens is chuted down, but a gravity incline is used for railroad shipments. The McKnight seam here has a thickness of 46 inches, and the Kellioka is 5 feet 6 inches. The tipple on the Kellioka seam is equipped with shaker screens. Electrical equipment is used throughout the mine and modern mining practices govern.

The town of Benham is in reality a model mining village, with the most of the modern conveniences that have of late years become necessities. It has a good hotel and a very good Y. M. C. A. building. A complete waterworks system has been installed for domestic use and fire protection.

Proposed Developments.—Proposed developments show that the Banners Fork Coal Co. has been organized and intends to build about 3 miles of railroad up Wallins Creek, and develop a tract of the Wallin coal.

The Harlan County Coal Co. has been organized and plans to put in a plant on Catrons Creek and mine the Harlan seam.

The King-Harlan Coal Co. has been organized and has leased the Harlan seam from the New York & Pennsylvania Coal Co.

The New York & Pennsylvania Coal Co. propose to construct about 5 miles of railroad from Ages to Clover Fork to Yocum Creek and up the creek. This is to develop their land at this point.

The Kentucky Utilities Co. has a transmission line from its central power station in the Pocket Coal Field down Yocum and Clover Fork to Harlan. This line will eventually be extended to Varilla.

The only railroad in this coal field at the present time is the Louisville & Nashville, and for 23 miles of its length it follows the Poor Fork of the Cumberland River. On this 23 miles there will be very little development of the coal beds, with the exception of the highest seams, as the lower strata are somewhat upturned from the Pine Mountain Fault.

This line will eventually be extended up Poor Fork to its head, and perhaps through the Proctor Gap, down the North Fork of the Pound River in Virginia to a junction near the Breaks with the Carolina, Clinchfield & Ohio Railroad. A branch line of necessity will be built up Clover Lick Creek and the one up Big Looney extending to the properties of the Wentz interests.

On Clover Fork and Martin's Fork there are at present 5 and 3 miles of railroad, respectively. The largest areas and the best coal in the field are found on these two streams and the mountain sides also contain large areas of good hardwood timber. It seems that either the railroads are not ready for this coal and timber to go to the markets, or they have failed to recognize a very valuable railroad proposition. On these two forks of the Cumberland a railroad could be constructed at a moderate cost that would find few equals as a freight road in this entire section of the United States. If built, the Louisville & Nashville or the Southern would have to obtain control of it.

The road in mind is one that would leave the Virginia & Southwestern Railroad at Keokee, Va., tunnel the Little Black Mountain at the Morris Gap on the head of Clover Fork and following Clover Fork, would connect with the Louisville & Nashville at Ages, or build on down the Fork to Harlan, then swing up Martin's Fork until the Falling Water Gap in the Stone Mountain is reached. Here another short tunnel would bring the road back to Virginia, and following down the Poor Valley for a short distance to Cumberland Gap, Tenn., it would connect with the Southern and also with the Louisville & Nashville. At this time a free right-of-way and a cash bonus awaits the individual or railroad that will put through the construction and operation of this proposed railroad line.

Branch lines will eventually be built up Catrons, Turtle, Crummies and Cranks creeks of Martin's Fork, and up Wallins and Forresters of the main river.

Wide Market Available.—With the railroads laid out, this brings us to the markets, and after all no matter how much coal we have or how good it is or how favorable our railroad facilities are, we must have a market.

The bulk of the coal from this field must now go to the North and West, where it has to compete with the cheaper coals of western Kentucky, Illinois, Indiana, and Ohio. Part of the tonnage goes to the South and Southeast, but the great markets of the Carolinas and the seaboard are cut off from this field. However, the railroad line mentioned above and a connection with the Carolina, Clinchfield & Ohio Railroad would make these markets available.

In the near future the seaboard trade, the Panama and other foreign business, should be partly filled with coal from this field, for with the quality of the coal produced, it is

safe to assume that it can compete with any coal in any market, barring excessive freight rates, and this means that this field must have railroads to place its coal in the best markets of the world.

The following statement of tonnage from Harlan County was obtained from Mr. C. J. Norwood, Chief Inspector of Mines for the State of Kentucky, and shows the commercial coal mined in the different years:

	Tons
In 1911	25,814
In 1912	384,427
In 1913	775,333
In 1914	1,250,310

The paper would not be complete without mention of the town of Harlan, in the center of the coal field at the junction of Clover and Martin's Fork, and just a little over a mile above the junction of these two with Poor Fork. Ten years ago it was a scattered, straggling mountain village, today is a city with beautiful residences and many good stores and office buildings, and with the proposed developments in the way of street improving, waterworks and sewer completed, it will be a city in every respect, a metropolis of a large coal field.

An Automatic Switch

A switch that is automatic and can be relied upon is much needed in the coal industry. Millhouse & Ball have designed such a device to be used at any motor parting or turnout where it is necessary to make flying switches.

When the motor with a trip of empties approaches the parting with sufficient speed to send the cars on the empty track, it is disconnected from the trip a few feet from the switch and runs ahead. The wheels strike dog *A*, Fig. 1, throwing the switch to empty track and at the same time lifting dog *B* to an upright position. The motor is then coupled on to the loaded trip and starts back for the tipple, shaft bottom, or whatever the case may be, as soon as the string of empties has cleared the switch. In so doing, the motor wheels strike the dog *B* which throws the switch back to its original position for the loaded track.

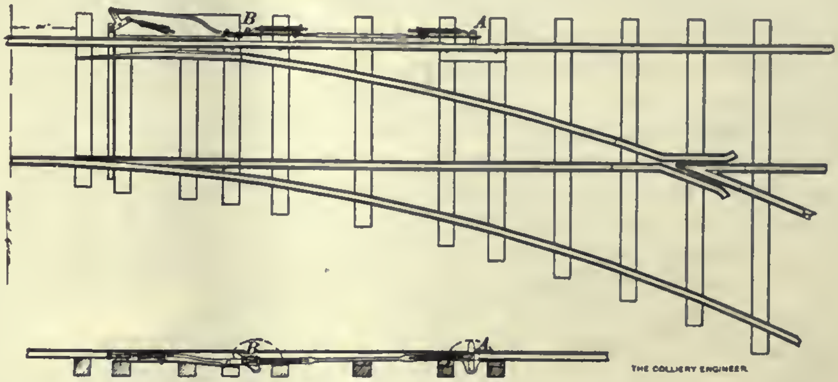

Fig. 1. Automatic Switch

The switch is easily operated and can be readily thrown, by pressing down on the proper dog with the foot. It is practically impossible to injure either of the switch points or the adjustment by running through the points when closed, as the wheels always throw the switch into the proper position. There is practically no upkeep save applying a little oil occasionally and keeping it free from accumulations of dust and dirt.

Approved Electric Apparatus

The Bureau of Mines has recently approved, for safety, practicability and efficiency, the miners' portable electric cap lamp manufactured by the Edison Storage Battery Co., of Orange, N. J. Approval No. 10 has been issued to that company. The only bulbs so far approved for use with the lamps of the company are the "26–V" bulbs manufactured by the Independent Lamp and Wire Co., 1733 Broadway, New York, N. Y.

The Bureau has also approved, as permissible for use in gaseous mines, an explosion-proof coal cutting equipment manufactured by the Sullivan Machinery Co., of Claremont, N. H., consisting of the following parts: One explosion-proof electric motor; one explosion-proof starting rheostat and fuse; one explosion-proof cable reel. The use of all of these parts is considered essential to the permissibility of the equipment. Approvals Nos. 100 and 100–A have been issued to the Sullivan Machinery Co.

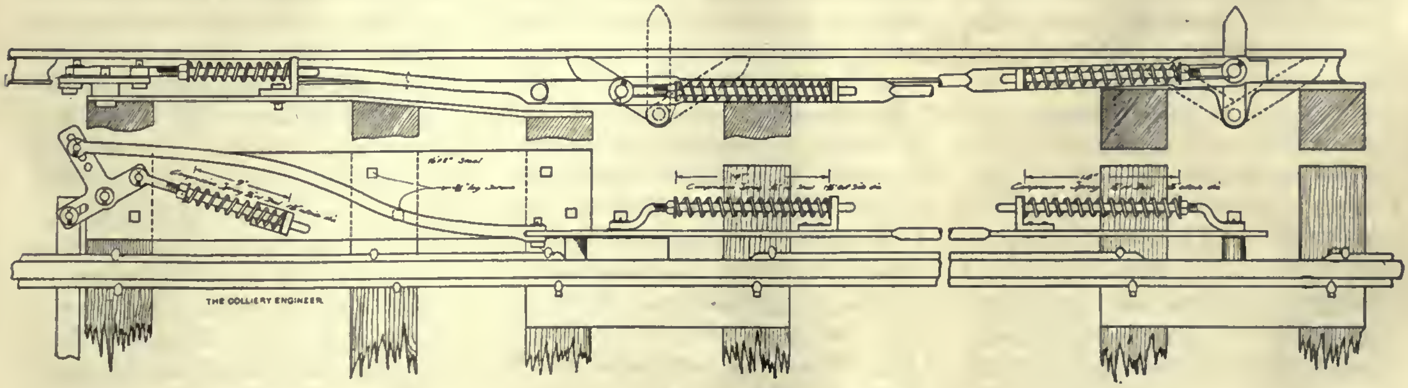

Fig. 2. Details of Operating Mechanism

Benzine Substitutes for Safety Lamps

In consequence of the growing scarcity of benzine in Germany, a number of experiments have been made to ascertain the best substitutes for or adjuncts to this oil, for use in safety lamps. Beyling made unsuccessful trials with a mixture of 25 parts of ordinary benzine and 75 of an oil composed of 2 parts of scrubber oil and 3 of benzol. Better results were obtained with a mixture consisting of 75 per cent. of alcohol and 25 per cent. of benzol; and the final conclusions arrived at are that this mixture is best adapted for the purpose in view, under certain precautions. As a partial substitute for benzine, additions of 10 to 20 per cent. of benzol are practicable. On the other hand, the use of heavy benzine, crude benzol, and petroleum is inadvisable, because either the light emitted is too feeble from the commencement, or else it diminishes in intensity very quickly in consequence of the heavier constituents remaining behind in the lamp whilst the lighter ones burn away first. With regard to the precautions necessary when the alcohol-benzol mixture is used, the lamps should be rinsed out with benzol and provided with fresh cotton wool and wick, because any residual benzine present will not mix with the (95 per cent.) alcohol, owing to the water contained in the latter. The benzol must be water-white and free from impurities (90 per cent. pure commercial benzol is suitable), since these would soon cause the wick to crust and also give a smoky flame. The lamps must be well cleaned after each shift, the wick being rubbed over with a wire brush, and the wick dust wiped out clean. Any greasy deposit on the igniter must be removed by means of a rag soaked in benzol. Given these precautions, the lamps will burn well for 10 hours at a stretch, a number having been in daily use for 3 months. Round burners give a light equal to .6 Hefner standard candle, and flat burners one equal to .9 Hefner, or about three-quarters the light of the ordinary benzine flame (height 34 millimeters). The mixture does not ignite so readily as benzine; nevertheless, certain ignition is obtained with paraffin-strip, paper-strip, and metallic-spark lighters. The wick burns away more rapidly than with benzine, flat wicks needing renewal every 4 weeks, and round wicks every 2 months. The cotton wool in the lamps does not clog, at least within the 3 months during which the trial lasted. The flame does not exhibit any greater tendency to smoke than the benzine flame, nor does it smoke the gauze or glass cylinder. In firedamp, it is even safer than the benzine flame, nor does its higher temperature make the lamp appreciably hotter. As a gas detector it is quite satisfactory, for while the rather greater brightness of the turned-down flame dims the flame cap in presence of 1 to 2 per cent. of methane, the cap is clearly discernible when 2 per cent. is present in the air; and with higher percentages the flame is extinguished in exactly the same way as the benzine flame.

Dobbelstein experimented with mixtures of benzine, and the first fraction (b. p. below 80° C.) obtained in the distillation of crude light benzol. A sufficient light for underground use was furnished by mixtures containing up to 45 per cent. of the last-named constituent, and 55 per cent. of benzine. The flame lights easily, and does not go out more readily than a benzine flame when the lamp is swung; nor does there seem to be any serious risk of corrosion of the gauze by the combustion of the carbon disulphide present in the distillate. The consumption of benzine can be still further reduced by the addition of alcohol (commercial 96 per cent. spirit) to the above type of mixture, the most satisfactory results being obtained with 60 per cent. of benzol distillate, 30 per cent. of alcohol, and 10 per cent. of benzine, which gives a flame with an illuminating power of .45 Hefner, and capable of burning for at least 20 hours without charring the wick.—*Colliery Guardian.*

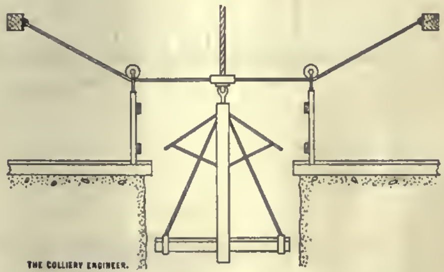

Fig. 1. Apparatus for Raising Shaft Gate

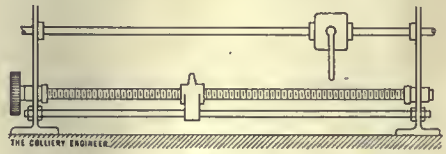

Fig. 2

Method of Raising Shaft Gates

The method of raising shaft gates illustrated in Fig. 1 is used at the Lucerne mine of the Rochester & Pittsburg Coal and Iron Co. at its upper shaft landing. A rope is run from a timber somewhat above the gate, through a small pulley attached to the gate and to a ring which encloses the hoisting rope. This ring is lifted when the cage reaches it, and the gates are raised. The device is very simple, perfectly reliable, and wholly automatic. The gates are always closed when the cage is below this landing and they are always open when it reaches the landing. A device illustrated in Fig. 2 is used for raising the gates at the shaft collar. A nut travels along on a threaded bar. As it passes the trigger it raises this, and compressed air is turned into the cylinder which raises the gate. When coal is being hoisted the nut passes this point so rapidly that only a little air is admitted to the cylinder and the gate is not opened. When the cage is stopped at the surface the valve remains open long enough to cause the raising of the gates.

The use of these devices was pointed out by Mr. George W. Brymer, chief engineer of the Rochester & Pittsburg Coal and Iron Co.

Fig. 1. Exhibit of Bureau of Mines at Panama-Pacific Exposition

The Panama-Pacific Exposition

A Description of the Principal Features Relating to the Mining Industry

By Special Correspondent

THE daily press and the popular magazines have made known the principal features and the general setting of the Panama-Pacific Industrial Exposition, which, therefore, needs here only a passing word by way of introduction to the Mining Building and its contents. A visitor should by all means enter first the main or Scott Street entrance, so that the first impression may be comprehensive and so that he may get an idea of the general grouping of the buildings and their architectural and artistic setting. Directly facing the main entrance is the Tower of Jewels on which are hung 135,000 specially cut prisms in the colors of the ruby, emerald, sapphire, topaz, diamond, and other precious stones. This tower is 435 feet high and beautiful as it is in the sunlight, the appearance at night under the variously colored search lights is indescribably beautiful.

The Exposition palaces are arranged in a rectangle with the Mining and Metallurgical Palace in the northeast corner, facing San Francisco Bay on the north. The other palaces in this group of eight are Transportation, Agriculture, and Food Products facing north; Education and Social Economy, Liberal Arts, Manufacturers and varied industries facing south. At the east end of the rectangle is the Machinery Building and across the west end and at some distance from the others is the Fine Arts. Just south of the Education Building is the Horticulture and south of the Manufacturers is the Festival Hall. These buildings cover 110 acres and cost $5,000,000 to build. They are connected by colonnades and separated by most beautiful gardens in which are appropriate and well-executed statuary. At the east end of this general group is the amusement portion called the Zone and west of the main central group are the state and foreign buildings.

The Mining and Metallurgical Building cost $359,445 and covers an area of 172,555 square feet. At the southwest corner of the building is the Court of Abundance designed by Louis C. Mullgardt in the Spanish-Moorish type of architecture. This is considered by many the choicest architectural feature in the Exposition and one of the towers is shown on the front cover of this issue. From the mining standpoint the most prominent feature in the building is undoubtedly the exhibit of the United States Bureau of Mines shown in Fig. 1. This is near the north entrance and is easily located by the head-frame shown in the photograph. This exhibit can be divided into three parts: The Mine which is underground, the general mining activities of the Bureau, and the general metallurgical activities. The Mine is undoubtedly the most striking as well as most popular exhibit in the building, if not on the Exposition grounds. The only other exhibit that competes with it in popularity is probably the Panama Canal exhibit on the Zone. The Mine is not a model, but a reproduction in full size of entries, drifts, stopes, and rooms selected to represent different phases of mining from different sections of the United States and in it are shown full-sized machines and appliances as used by the miner. The object of the exhibit is to show the general public the actual conditions inside a mine, and the designers have been most successful in faithfully portraying underground conditions. The engineers of the United States Bureau of Mines formulated the plans for the installation of the exhibit and the installation was carried out under the supervision of the Bureau in cooperation with Mr. C. E. van Barneveld, Chief of the Mines and Metallurgy Division of the Exposition, who most earnestly and faithfully assisted the Bureau in gathering the exhibit and in its installation. As there were not sufficient Federal funds available for the display as designed, a number of mining and machinery companies were invited to participate in the exhibit. Ten mining companies and about twenty mining machinery and safety-appliance companies contributed about $21,000 toward the cost of construction and for the maintenance of the Mine during the Exposition period. The several mining companies in addition to cash subscriptions furnished ore, coal, and other materials with which to make the exhibit realistic. Mining machinery and safety appliance companies in addition to their cash subscriptions also furnished apparatus. It is estimated that Mr. H. M. Wilson, engineer in charge of the Bureau, wrote at least 10,000 letters in arranging for the exhibit in addition to making a trip throughout the United States for personal consultations relative to the matter.

The Mine is built in filled land dredged in from San Francisco Bay, and as the lower level of the mine floor is 6 feet below sea level and only about 300 feet from the Bay, water seeps through the sand, and to carry on the installation two shafts had to be sunk through the quicksand and a boxed ditch laid to drain the area on which the Mine was to be built. In order to keep the Mine free from water, pumps are in constant operation. Owing to the nature of the filled ground a very offensive odor would be present if it were not for the adequate ventilating system that has been provided. The approximate cost of the Mine was $14,000 and its operation and maintenance have cost $7,000. The stopes and rooms were designed by the contributing mining companies interested, who furnished drawings; and in many instances framed timbers and other supplies were sent from the mines, as well as the ore and coal used in the installations. This material was generally put in place by the employes of the Bureau of Mines from the drawings furnished by the mine owners. Ten men are constantly employed in the mine under the direct orders of a mine foreman, and on several special days the attendance has been as high as 18,000 people.

Entrance to the Mine is secured either through a drift, which leads to a stairway simulating a slope entrance, or through a shaft which has been very cleverly designed, so that as one enters the mine cage a panoramic effect is produced as of looking out of a window. Then the cage door is closed and a canvas panorama composing the walls passes slowly at first, then more rapidly and meanwhile the cage shakes as if it were being rapidly lowered, then the cage appears to gradually descend and finally it reaches the bottom of the shaft not far below where one has entered it. The plan of the underground workings is shown in Fig. 4. Although the mine is lighted by electricity, the trip underground is made more realistic by each person being handed either a Koehler safety, Ceag electric, or a Baldwin carbide lamp, which lamps are displayed by the manufacturers in booths near the foot of the slope stairway. These booths, which also contain various lighting devices and appliances used in a mine lamp room, are occupied by the Life Saving Devices Co., the Concordia Safety Lamp Co., the Mine Safety Appliances Co., and the Baldwin Carbide Lamp Co. The Mine Safety Appliances Co., in addition to its lighting devices, also shows the Edison storage-battery cap lamp, the Lungmotor, Fleuss breathing apparatus, and the Bacharach air meters and pressure gauges. Across from the lighting devices are the underground magazines for powder and for caps, Figs. 2 and 3, exhibited by the Ensign-Bickford Co., the Coast Mfg. and Supply Co., and the Hercules Powder Co.

Readers of The Colliery Engineer, although primarily interested in coal mining, will find much of interest in the ore mining rooms and stopes, which permit an excellent comparison to be made with coal mining methods. It is seldom that coal and ore mining methods can be seen so closely side by side as they are in the Mine, where underground conditions have been so faithfully reproduced that an excellent idea

can be obtained of either phase of mining.

The Goldfield Consolidated Mines Co., of Goldfield, Nev., shows a stope in which all timbers and other accessories are exact reproductions of those used in the mine. Waugh and Ingersoll drills and a small Sirocco fan are included in the exhibit.

An underground Mesabi iron mine, the Lincoln mine at Virginia City, Minn., is shown by Jones & Laughlin Steel Co., Fig. 5. This illustrates the square-set method of mining mass iron ore deposits.

The Copper Queen Consolidated Co.'s mine at Bisbee, Ariz., is a most realistic exhibit, as ore was brought from the mine and placed in the mine walls and faces most naturally.

COAL MINING EXHIBITS

Coal mining is represented by five rooms showing mining methods in different parts of the United States. Anthracite mining is represented only by an exhibit of the Lehigh Coal and Navigation Co., of Lansford, Pa., which shows the Mammoth bed nearly vertical with a cross-cut from the main gangway of the mine to a top split of the coal bed. A timber chute is shown loading into a low bituminous mine car, giving not a very realistic impression. The actual mining method is not shown, excepting by means of a photograph of the model displayed by the anthracite companies at the St. Louis Exposition. The impression given by this display to one not familiar with anthracite conditions is merely a thick steeply inclined bed of coal, and the questions asked by the ore mining men who visited the exhibit showed that it did not give the same insight into anthracite methods as did the exhibits from other coal fields.

Fig. 2. A Powder Magazine

Fig. 3. Magazine for Caps and Fuse

Fig. 8 shows a reproduction of a room in the Elkhorn, Ky., mines of the Consolidation Coal Co., of Fairmont, W. Va. This coal seam has a slate parting in the center, and a Jeffrey-Drennan turret coal cutter is mounted to cut in this parting. In the same room the Fairmont Mining Machinery Co. exhibits an electric coal auger and a portable electrically driven pump, also steel mine ties. The Consolidation Coal Co. also has at the south entrance to the building a booth in which full sections of its coal are shown, as well as an interesting collection of photographs, charts, and diagrams, all in charge of a most competent attendant. The large full sections of coal have been gotten out and transported to the Exposition at a very considerable expense and trouble.

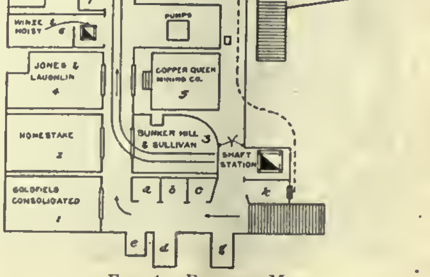

Fig. 4. Plan of Mine

Room 11 shows the method of working in the Pocahontas Consolidated Collieries Co. mines located in the famous smokeless Pocahontas

coal field in southern West Virginia. A shortwall Jeffrey machine is shown and the value of the exhibit is greatly enhanced by a series of six diagrams showing in detail the method of working. The other coal exhibits would be much better understood if they were similarly accompanied by such plans and drawings.

The Southern Wyoming Coal Operators' Association exhibits a room typical of conditions in the Rocky Mountain subbituminous mines at Rock Springs, Wyo. The mine at that place furnishes fuel for the Union Pacific Railroad, and while the exhibit is very good as a whole, the mine car shown is not of a type to be recommended in coal mines, as it is of slat construction that permits much waste along the road and greatly facilitates the production of dust. A post auger drill is shown in operation.

The Pacific Coast Coal Co.'s exhibit represents a steeply pitching thin seam of coal, the coal reaching the gangway through a central chute with a manway alongside. At the face are several forms of coal drills. This is one of the best reproductions in the Mine of actual working conditions, but owing to the difficulty in reaching the working face up the low chute very few visitors will see and appreciate fully the exhibit.

The mechanical equipment of mines is represented in the Mine by the following items:

Haulage and Hoisting.—Two Baldwin electric mine locomotives are shown, one a 42-inch gauge trolley gathering locomotive operated on the track leading from the neck of the Pocahontas Collieries Co.'s room, and a similar make 24-inch gauge storage-battery locomotive is represented as pulling the car from the Bunker Hill & Sullivan stope. All of the track and ties used in the mine are of steel. A full-size Canton, Ohio, automatic mine door is operated on the track along which the 42-inch gauge trolley gathering locomotive runs. The mine cage referred to above is made by the Joshua Hendy Iron Works and the hoisting engine by the Denver Engineering Works. A Leadville drill-column hoist is exhibited in the winze shown in Fig. 6, also a number of drills.

Ventilation, Drainage, and Lighting.—As noted before, the Mine is at a lower level than San Francisco Bay, and though it has a concrete floor to keep out the water, constant pumping is necessary. For this purpose there are two pumps available, one a 1,000-gallon capacity Byron-Jackson centrifugal pump and a smaller one a 10-gallon pump connected direct to a Westinghouse motor. There is also a 150-gallon Jackson sinking pump. A 300-foot single-stage air compressor of the General Machinery and Supply Co. is belt-connected to a 75-horsepower Westinghouse motor and furnishes the air necessary to operate the drill equipment of the Mine.

The fact that the Mine is below water level probably accounts for the very natural mine odor which is the first thing that strikes a person entering the Mine. Excellent ventilation is maintained, however, by the Sirocco fan at the surface near the hoisting shaft, while a number of smaller fans of similar make placed at various points in the Mine assist in the ventilation. The American Blower Co. has also exhibited an excellent model of a reversible mine fan.

There is telephonic connection throughout the mine and with the surface plant by means of Western Electric mine telephones. This company also has exhibited a new rescue telephone which can be carried by a rescue party, and communication can be had from a central point outside of a mine or of the danger zone with each member of a rescue party by means of an ingenious device which allows each member of a rescue party to be in constant communication with the base. As a rescue party retreats instead of attempting to save the cable it is cut and abandoned.

One of the best patronized and most instructive places on the Exposition grounds is the "movie" theater in the Mine, Fig. 7. Here are shown each day most excellent films of copper mining and concentration by the Utah Copper Co., at Bingham Cañon and the Nevada Consolidated, at McGill Flat, Nev. The operations at the mills of these companies at Magno and Garfield are also shown. Other reels show the quarrying and dressing of Bedford limestone in Indiana, the use of the Bucyrus shovel in stripping coal and iron, the various uses of explosives, also coal mining scenes and the processes of concentrating carnotite ore and extracting radium and radium salts in the Bureau of Mines plant at Denver. One exit from the Mine is through the radium booth where the visitor can examine through the glass the various radium salts and compounds.

The exhibit of the Bureau is intended to show an outline of the various activities of the Bureau. It contains in addition to the entrances and other accessories of the mine, cabinets having a good selection of safety lamps and other lighting devices. Various explosives and the ingredients used in their manufacture are shown, also timbers treated to prevent decay, samples of coal, and ore such as molybdenum, vanadium, and other rare metals, and a rescue hospital and various types of oxygen breathing apparatus.

The testing and use of explosives is shown by photographs as is also a welfare exhibit which includes in addition to photographs a map showing the design for an industrial village. By simultaneous flashes of small electric lights the point on the map and the photograph of the building located at the given point on the map are shown. In this way different features of welfare exhibit are brought out consecutively. Apparatus is shown for demonstrating the explosibility of coal dust, also the model of a dust barrier as developed by Mr. George S. Rice and other engineers of the Bureau. The oxygen breathing apparatus are the Fleuss, Proto, Draeger, and Westfalia types.

The metallurgical exhibit, shown in Fig. 1 beyond the aisle, aims to demonstrate the activities of an actual working laboratory and to show by photographs, charts, models, etc., the processes related to the investigations being carried out by the Bureau. There are two general divisions of the exhibit: One representing hydrometallurgy and another fire metallurgy.

Fig. 5. Lincoln Mine

Fig. 6. Winze in Mêtal Mine

Every day at 11 A. M. and 2 P. M. the visitors in the Mining Building are attracted by an explosion which is heard in one of the surface buildings of the Mine. A loud report is followed by a puff of smoke coming out of the building and immediately thereupon the superintendent in charge of the Mine telephones into the Mine to determine the cause of the trouble and then calls up the rescue corps of the Bureau, which comes from what seems a far off part of the grounds with the large white auto truck. This truck carries a complete outfit of rescue equipment and a trained crew of ten men. These men put on the artificial breathing apparatus, enter the smoke room to test their apparatus for leaks, and after coming out enter the Mine and in a few moments return to the surface bringing a supposed victim on a stretcher. Artificial respiration is applied and various fictitious wounds are bandaged, this first-aid treatment being carried on under the management of the United States Public Health Service, which has equipped a hospital in one corner of the Bureau of Mines exhibit.

Next to the Bureau of Mines exhibit is that of the United States Geological Survey, showing by maps, charts, diagrams, photographs, and models, the activities of that branch of the government which is first cousin to the mining industry. There is one most interesting model of thawing frozen ground in Alaska and an appropriate Alaskan panorama showing the various methods of mining in use in that far north land.

Next to the Geological Survey is a model post office and nearby a miniature mint in operation coining a medallion souvenir of the Exposition.

The mining machinery exhibits aside from those already mentioned in connection with the Mine are an almost negligible feature of the Exposition, indicating that the manufacturers of such machinery have grown tired of the Exposition form of advertisement. In the Transportation Building the General Electric Co. has exhibited one 20-ton 42-inch gauge trolley type locomotive and a combined trolley-storage type 42-inch gauge locomotive with an Edison storage battery. The same company also shows its mine lamp.

In the Machinery Building the Doak Engine Co. and the Western Gas Engine Co. show gasoline hoisting engines. In the Mining Building the Pacific Pipe and Tank Co. shows wooden pipe and various forms of tank construction. In the center of the Palace of Mines the Yuba Construction Co. has a working model of a gold dredge that is most realistic and one of the very best exhibits to be seen anywhere. Placed in a concrete tank and electrically operated, it digs gravel which runs over the gold tables and the tailings are stacked behind the dredge. This dredge operates in the morning and a similar one in the California Building operates each afternoon.

A number of concentrating tables are exhibited, but general mining, concentrating and metallurgical machines are meagerly displayed.

Near the east door the Hercules Powder Co. and the California Cap

Fig. 7. Underground Movie Theater

Co. have an excellent exhibit showing different explosives and the ingredients used in their manufacture, a model of a black powder mill, a magazine, and the models of testing caps, and of using explosives. The Coast Mfg. and Supply Co. also has a magazine exhibit nearby.

Fig. 8. Elkhorn, Ky., Mine of Consolidation Coal Co.

The various state exhibits contain the usual displays of ores and other mineral products and in some cases good collections of photographs and diagrams. A catalog of many of the rock piles would not be of interest to the readers of this paper and only the features that have a direct practical mine bearing will be noted.

In the New York exhibit the Sterling Salt Co. has a model showing room-and-pillar methods of working a flat deposit of salt 20 feet thick at a depth of 1,000 feet when 14 feet of the salt deposit is taken out. The Worcester Salt Co. shows the method of obtaining salt by pumping by means of an ingenious model which also shows the surface preparation of table salt. In the same state exhibit the Witherbee-Sherman Iron Co. has a glass model of the famous old bed magnetite deposit.

In the Missouri space is a model of the Oronogo Circle Mining Co. showing the methods of mining zinc in sheet ground. An excellent display of photographs also gives the entire process of prospecting, mining, and concentrating in the Joplin district.

The California exhibit contains an excellent panorama of a hydraulic mine showing giants at work and a proposed, but as yet untried, method of impounding coarse tailings behind dams and allowing the fine material to settle within barriers, so as to enrich the land. The Mammoth Mining Co. shows a mine entrance and a number of glass models. In the California exhibit is also a stamp mill and a collection of photographs by counties. In the California Building there is the dredge already noted and also a small stamp battery that is operating.

The Nevada exhibit contains wooden models of a proposed triangular timbering method, the original square-set timber model from the Comstock mines, and a good collection of glass models. The Anaconda Copper Co. shows its various products and the exhibit is particularly rich in mine models, which include a most elaborate stope model of the Leonard mine showing all of the timbering, a model of the Leonard pump station and head-frame, square-set timbering, cyanide plant, various glass models and skeleton vein geological models.

A most interesting exhibit is that of the Transvaal Chamber of Mines, including two gilt globes which show the relation between the gold output of the Transvaal and that of the world. By means of an automatic stereopticon, photographs of underground methods of the Rand are most strikingly shown.

The most extensive exhibit in the Palace of Mines is that of the United States Steel Corporation, which includes the iron and steel industry from the prospecting for the iron and coal to the utilization of the finished products. As the company has described this exhibit in a 56-page pamphlet, it is manifestly impossible in a single magazine article to do justice to it as a whole and only the salient mining features can be selected. The Bureau of Safety, Sanitation, and Welfare has a large collection of photographs, signs, and safety appliances showing the campaign that it is carrying on for "safety first," rescue, and welfare work. This exhibit includes all branches of the United States Steel Corporation and only a small part is devoted to mining, but there are several interesting models showing safety devices in connection with hoisting and particularly with the use of explosives.

The mining of iron is shown by a comprehensive set of photographs and charts. An excellent model is shown of the large Sauntry Alpena open-pit mine. The transportation of ore is shown by models, photographs of ore docks and lake carrying boats. The mining of coal is illustrated only by photographs, and the preparation of coke by a very complete working model of a modern surface coal plant in the Connellsville region. All of the buildings of an up-to-date plant are shown, and the larries moving back and forth give a realistic appearance to the model. The United States Steel Corporation also maintains a moving picture theater and each day beginning at 11 A. M. the

following program of films is given: Ore exploration and mining methods; Scenes at the ore docks, mechanical unloaders, transportation by boat and by railroad; Coal mining, coke manufacture, safety and sanitation methods used in the Pennsylvania and West Virginia coal fields; Blast furnaces, steel mill operations; Manufacture of wire and wire fencing; National pipe, seamless tubes, pipe fittings, etc.; Concrete road making; sheet steel, tin plate galvanized sheets, tin roofing.

The entire exhibit of the United States Steel Corporation is most excellent in design and most carefully displayed and it is only to be regretted that more attention was not given to the coal mining part of the Corporation's activities. An office is maintained in the exhibit and through a number of attendants every effort is made to welcome the visitor and to make plain to him the entire display.

The Japanese government has in the Mining Palace a very comprehensive exhibit which is well worth careful study.

In the Mining Palace the oil exhibits of the Standard Oil Co. and the Union Oil Co. are well worth visiting. The Standard, in addition to showing its products, has a number of panoramas showing the methods of drilling operations. The Union Company has a most comprehensive panorama showing a California oil field. Other mineral exhibits will be found in the Australian, Canadian, and California buildings, and also in some of the other foreign buildings.

Moving pictures of coal mining are also shown in the Illinois Building.

No description of mining would be complete without reference to the Panama Canal shown on the Zone. This is a large topographic model of the Canal showing the features in perfect detail. A novel method is used to explain the exhibit to visitors who sit on an eliptical moving platform that moves about the depressed topographic model. As a person comes opposite each section of the model a description is given to him through a telephone receiver that is placed in his ears and in this way the usual Exposition barker is done away with entirely.

The mining exhibits are primarily educational rather than of an advertising nature and great credit is due Director van Barneveld for gathering so large and interesting an exhibit under conditions that were far from favorable.

Vertical Curve for Conveyers and Inclined Planes

By R. J. Sampsom

The installation of the rope disk conveyer as a retarder is becoming a rather common thing where the seam is high in the mountain and coal is to be lowered through a short distance.

We recall one installation where the inclination of the trough of the conveyer was 34 degrees and the distance from center to center of bull wheels 826 feet. At the foot of the slope was a small river—the tipple was in the river "bottom"—at a distance of about 275 feet from the bottom bull wheel.

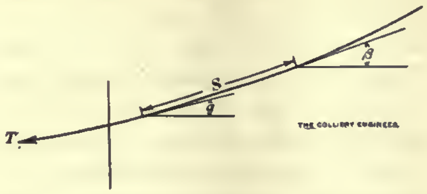

FIG. 1

It was decided to bring the coal down the mountain and across the river with a rope disk retarding conveyer, discharging on to a belt, which carried it to the screens. The trough was 18 inches deep, 12 inches wide at the bottom, and 36 inches at the top. The disks were 12 inches in diameter, spaced 4 feet centers on a ⅞-inch rope.

A curve of 600-foot radius was used in crossing the river and bringing the conveyer line tangent to the horizontal, at its discharging point.

The greatest trouble encountered was the fact that the rope would "ride" the coal, on the curve, so badly, that it was frequently necessary for some one to "start" the coal in the trough at this point.

The following suggestion is probably more of a theoretical remedy than a practical one.

A rope suspended at each end, hanging freely, will assume the shape of the mathematical curve, catenary, the equation of which is difficult to apply in practice. The curve most nearly approaching the shape of the catenary is the parabola. Our suggestion is then, to build the conveyer on a parabolic curve instead of on the arc of a circle. The greatest distance between the two curves will be about the center. At this point the parabola is some distance above the circular arc.

If the riding of the coal by the rope were caused by buckling of the rope, added tension on the rope would tend to raise it (when hanging freely), and produce the same result. In other words, the rope with sufficient initial tension to prevent buckling when the load is applied, could be made to coincide with a parabolic curve but not a circular one.

In a case of this kind the P. T. is, of course, determined by the position of the tipple, etc. The inclination of the conveyer line having been decided by the general slope of the hillside, the intersection of the two tangents can be computed.

The equation of a tangent to a parabola is

$$x = sy + b \qquad (1)$$

But this line is to be tangent to a parabola, having its vertex at the origin of coordinates and its directrix parallel to the x axis.

The equation of such a parabola is

$$x^2 = 4py \qquad (2)$$

In which p = the distance from origin to the focus.

The equation of a tangent to this parabola at the point x'', y'', is

$$xx'' = 2p\,(y + y'') \qquad (3)$$

By geometry $x'' = 2b$; in which x'' is the abscissa of the point of tangency and b the tangent's intercept on the x axis.

Substituting this value in

$$x'' = sy'' + b$$

$$y'' = \frac{b}{s}$$

Also, in $x''^2 = 4\ py''$

$$4b^2 = 4\ py''$$

$$y'' = \frac{b^2}{p}$$

$$\therefore \frac{b}{s} = \frac{b^2}{p}$$

$$s = \frac{p}{b} \text{ or } b = \frac{p}{s}$$

In which both b and s are known; therefore the constant p, in the parabolic equation can be found. By substituting for x the values determined by the horizontal distance between bents of the structure, and solving for y, a parabola may be traced which will fulfill all of the above conditions.

A somewhat similar problem confronts the engineer who is called upon to lay out a gravity inclined plane, as it is frequently necessary to insert a vertical curve—in which case—a parabola would more nearly conform to the free hanging rope curve.

There has been derived a formula for "free hanging rope curves" which is the outgrowth of a problem presented to engineers in the Lake Superior copper district.

The shafts of this district are very deep and it is necessary, in many cases, to use in them a vertical curve. It was found that the use of a circular arc was accompanied by a rubbing of the rope on the hanging wall, causing not only additional wear on the rope, but increased danger to those riding in the shaft.

The first attempt to better these conditions was the use of a compound curve of decreasing radius. This has recently been abandoned in favor of the parabola.

$$S = \frac{T}{w}(\cos a \tan \beta - \sin a) \text{(See Fig. 1)}$$

Fig. 1 is a curve plotted from this formula. In the comparison of the parabola with the circular arc, the load was not considered, it is uniformly distributed and the free hanging curves (or the catenary) of the rope would not be disturbed.

Meeting of the Illinois Mining Institute

The summer meeting of the Illinois Mining Institute was held in Danville, May 27, 28, and 29. The papers presented were as follows:

"Design of Concrete Mine Shafts," A. F. Allard, chief engineer Bunsen Coal Co.

"Alternating Current and Its Use in Mines," W. D. Cameron, General Electric Co.

"Roof and Roof Intrusions," John E. Jones, State Mine Inspector, Benton, Ill.

"Mine Ventilation With Special Reference to Blowing and Exhaust Systems for Gaseous Mines," W. J. Montgomery, Jeffrey Mfg. Co.

"The Goodman Straight-Face Coal Cutter," H. H. Small, Goodman Mfg. Co.

"A Plan for Pillar Drawing in Illinois Coal," C. A. Herbert.

"The Miners and Mechanics Institutes," R. Y. Williams, Director, Illinois Miners and Mechanics Institutes.

The last paper gave occasion for considerable discussion. There seems to be an impression that the Miners and Mechanics Institutes are a part of the Department of Mining Engineering of the State University, and that the University is attempting to get control of the mining industry of the state, so far, at least, as it is possible for such an institution to do so. We are inclined to think that the only wish for any part in the control of the mining activities of this state, which can possibly be felt by the mining department of the University, is based upon the desire to do something to help the coal industry of the state. It really looks as if some help were needed. When it is considered that a large part of the coal producers of the state are in the hands of receivers, it must be admitted that the business situation is not good; and when it is considered further that in the room-and-pillar mines of the state there are very few cases in which more than about 50 per cent. of the coal is recovered, it must be admitted that the industry is not in a good condition from the standpoint of economics. Probably the Department of Mining Engineering would be very glad to feel no responsibility at all, but, if it does feel any responsibility, it may very reasonably hope that its efforts may lead to some improvement. As a matter of fact the Miners and Mechanics Institutes are not a part of the Department of Mining Engineering of the State University.

Wherever the work of the Institute has been carried on, it has met with very enthusiastic success and the results have shown that there are in the mining communities of the state a great many people who are very eager for knowledge which the common schools cannot give them. Such training as is being given must lead to more economical mining and to the decrease of accidents.

The committee in charge of arrangements had planned an automobile trip to some of the strippings and mines in the vicinity but an almost constant rain made this trip impossible, and a trolley ride to the stripping of the Two Rivers Coal Co. was substituted. In spite of the unfavorable circumstances, this trip was very pleasant. The car stopped for a short time at the stripping of the Mission Field Coal Co., where the first large revolving shovel manufactured is still at work.

A very enjoyable part of the meeting was the banquet given Friday evening by the operators of the district.

The present membership of the Institute is 210 and about 100 attended the meeting. The next meeting will be held in November at a place to be selected by the president and executive committee.

Too much emphasis cannot be laid on the importance of keeping the boiler tubes of fire-tube boilers free from soot; anything that will facilitate this works to the benefit of the user in reducing his coal bills and in prolonging the life of the boiler.

Use and Abuse of Oil at Mines

Different Grades of Oils—Proper Methods of Application—Changes in Oils by Wear

By C. T. Thomsen, B. Sc.*

THE quality of different oils on the market varies considerably and they may be divided into three classes, as follows:

High-grade oils containing a maximum amount of lubricating power, and all highly specialized.

Intermediate-grade oils of good and uniform quality, but not so high in lubricating quality, nor so highly specialized as the high-grade oils.

Low-grade oils made to suit conditions where first cost is the primary consideration, or where a higher grade of oils cannot be used to advantage, owing to unavoidable waste of oil or to unsuitable methods of lubrication.

It is the custom of many concerns to advertise bids for oil according to certain chemical specifications. This practice is wrong because the chemical composition does not show the lubricating power. It is possible to duplicate a high-grade oil on the basis of chemical tests by means of an imperfectly manufactured and inferior article. Thus the chemical tests may be the same but the results widely different in actual use.

Some people test oils by rubbing them in their hands, smelling them, tasting them, and looking at their more or less attractive colors. A heavy-bodied oil will feel excellent between the fingers, but if it be applied, say, on a high-speed bearing of a dynamo, the bearing will soon become warm. Smelling and tasting an oil may give some idea as to its constituents, but even the best trained chemists admit that this is an extremely doubtful method.

Oil cannot be judged by its color, as it is possible to give it any desired color. Imperfectly manufactured oils are sometimes colored to give them an attractive appearance. Apart, however, from the coloring of oils artificially, it is generally true that dark lubricants contain more lubricating power than light-colored ones.

Friction testing machines are to be discouraged. Comparisons in this case are meaningless. The following case will illustrate the discrepancies arising from the use of this method. A certain government employed an oil testing machine with which competing oil products were tried. The oils were intended to be used on naval machinery. One firm submitted a sample of high-grade dynamo oil which was quite unsuitable for marine work, but suitable for the testing-machine bearings, which were running at high speed. It showed up three times better than the various marine oils tested, including one oil of a much higher grade. This proves that the only accurate way of testing lubricants is to try them under working conditions, where they are to be used.

When talking to men directly interested in the successful running of machinery, one is often assured that they have no trouble; the idea being that the machinery is operating without any unusual heating of bearings or engine parts. In many such plants, however, the mere change from low-grade oils to better grades had effected a saving in power of 20 per cent. It is now realized that there is something beyond having "no trouble," and that a few degrees of frictional heat removed from every bearing in the mill or shop means so much off the coal bill.

A troublesome bearing in nine cases out of ten will not indicate that the oil is unsuitable, but that some mechanical defect exists in its construction. It is not an occasional hot bearing but the few degrees of unnecessary frictional heat that are wasted away in hundreds of bearings that determine the real standard of lubrication.

By means of accurate temperature tests it is, however, possible in nearly every case to make a comparison between the lubricating qualities of different oils, and it is to be recommended that such test be made as thorough and as careful as possible on selected bearings. These temperature tests should be repeated from time to time, with a view to controlling the quality of the oils in use. If the mechanical conditions do not change, the rise in temperature of the bearings above the surrounding atmosphere should remain very nearly constant.

When a new motor exhibits a tendency to develop heat in one bearing, the latter should be examined at once. If it is in good condition, the cause of the heating will probably be found in the thrust of the armature shaft against the bearing, which may result from either of two conditions: First, the machine may not be level and the shaft may dip toward that end. Second, the magnetic centers of the pole pieces and armature may not be in line; that is, the pole pieces may not be exactly centered in their relation to the magnetic center of the armature axially, and as the tendency of the armature is to run to the true magnetic center, it will automatically tend to adjust itself to that position. This may cause the shaft collar to rub against the bearings at one end, and so cause heating of that bearing.

*Read, March 19, before the Association of Mining Electrical Engineers (West of Scotland Branch).

Where low-grade mineral oils, or those with mineral base and compounded with animal or vegetable oils, are employed, they will become gummy in the bearings, and necessitate frequent cleaning. Such cleaning is unnecessary when high-grade oils are employed; cases have been known where such oils have been in use for years without any necessity for cleaning out the bearings and oil wells. However, it is desirable to empty the bearings every 3 or 4 months, and put the oil through a suitable filter. It will then be as good as new, and can be used over and over again, being mixed with a little fresh oil to compensate any loss.

The question of the internal lubrication of steam engines is of great importance. Nothing is more capable of destroying the good effects of high-grade cylinder oil than applying it in a wrong manner, or through unsuitable lubricators.

It has been found that the steam itself, which goes from the steam main into the engine and touches every part of the frictional surfaces, is the best medium to carry the oil to the places where it is needed.

It is important, however, for the steam to be impermeated with the oil. This can best be done by the use of an atomizer. The steam on its way through the engine, will therefore carry along particles of oil which will come in contact with all surfaces needing lubrication; and, assuming that the cylinder oil is a good one, selected only for that class of work, perfect lubrication will be insured.

Where compound engines are lubricated by feeding the cylinder oil into the high-pressure steam main, it is quite evident that, as the oil gets thoroughly broken up into the steam, the latter may often arrive at the low-pressure cylinder having sufficient lubricating properties to effect full lubrication. In many cases it is not therefore necessary to have oil fed direct to the lower stages.

In dealing with cases where superheated steam is in use, it is absolutely essential that only the highest grade of oil be employed, also that the lubricator should be of a first-class make of the mechanically operated forced feed type, capable of furnishing a very sparing and uniform feed of oil into the main steam pipe, the oil being introduced into the central flow of steam. The characteristics of a cylinder oil for use with a superheat should include a fairly high flash point, and no tendency to carbonization.

Most of the cylinder oil introduced into a steam engine will be carried through with the exhaust steam, and in the case of surface condensing engines, or where open feedwater heaters are installed, there is a great probability of the oil getting into the boilers, which would decrease the boiler efficiency considerably, and increase the danger of boiler explosion or furnace collapse.

Electrical treatment of the feedwater will extract every trace of oil. In the case of jet condensing engines, the possibility of oil getting into the boilers is very much less than that in the case of surface condensing engines, as the oil is mixed with such large quantities of water.

When the boiler feedwater is hard, and softened by a boiler compound, and the boilers "prime," the solid matters carried over to the steam engine will deposit themselves behind the piston rings, in the clearance spaces of the cylinders, and in other places, amalgamating with the cylinder oil and forming deposits, the presence of which is often put down to carbonization of the cylinder oil. It is true that unsuitable or low-grade cylinder oils may form deposits and carbonize, but in many cases the deposit can be traced to the boiler conditions.

The best practice for hoisting engines is to employ mechanically operated forced-feed lubricators feeding the oil into the main steam pipe through an atomizer. One oil feed will usually do to supply all requirements for the internal lubrication of the throttle valve, and two cylinders, if the steam pipe goes to each cylinder through pipes of the same size.

The advantages resulting from this manner of applying a high-grade cylinder oil are many. (1) There is no waste of oil as it is fed into the main steam pipe. It is in direct proportion to the number of revolutions made by the engine; the lubricator stops feeding when the engine comes to rest. (2) As the oil is properly atomized and distributed throughout the body of the steam, the main and the throttle valve will be lubricated, and therefore easier to handle, and wear will be reduced. (3) Each engine will receive its portion of the oil required for satisfactory lubrication, and it will be found unnecessary to use the grease cups for giving an extra dose of cylinder oil direct into the cylinders, as when the oil is not properly atomized. (4) As the steam is thoroughly lubricated, the valve rods and piston rod when coming inside the steam chest or cylinder will be coated with a film of oil, and thus receive their share of the lubrication, which in turn will mean a better lubrication of the gland packing, whether metallic or soft. Accordingly, less wear of the piston and valve rods will be apparent, and the packing will have a longer life. Hence, it will be necessary to apply cylinder oil externally on the rods. (5) Owing to better lubrication of the valve glands and of the valves, the reversing lever will be easier to operate; and this is a point greatly appreciated by hoisting engineers; in fact, every change in the grade of cylinder oil or in the method of lubrication will always be noticeable in the pull required to shift the reversing lever. (6) Owing to better lubrication, which means less power consumed in overcoming the friction, the engineers find that they can shut off steam earlier when the cage is nearing the end of its journey, and also that they can accelerate the engines and the cage more quickly or with less opening of the throttle valve.

In the forced lubrication system of high-speed enclosed steam engines the oil is forced by a pump under pressure to all bearings,

draining back to the oil suction chamber, and in this way circulating continuously. Oils for this purpose should be made to withstand the action of water and air, and must not deteriorate with long use.

Water gets into the crank-chamber owing to the presence of ill fitting glands or "scored" rods. The oil which is carried up from the crank-chamber and scraped off, together with the water, should be drained outside the crank-chamber. Metallic packings are preferable in such engines, as there is less danger of "scoring" the rods than with soft packing.

Every plant should have a steam filter, so that the oil, which varies from 1 to 6 gallons of oil per day (according to conditions), may be removed for subsequent treatment. This may be done in a steam heated separating tank, and afterwards in a good filter. The purified oil should be returned to the crank-chamber at the same time as the corresponding quantity is drawn off for treatment. In this way the vitality of the oil is maintained at a high standard.

The chief cause of water leaking into the oil is usually the gland packing. Steam passes from the gland packings into the main bearings and condenses on their surfaces. In cases of exhaust and mixed pressure turbines, it is particularly difficult to prevent leakage of condensed steam from the glands to the bearings, and the engine attendant should use great care to keep this leakage as low as possible. Water may also leak into the oil from the water cooling coils in the oil cooler, or from the water-jackets of the main bearings.

Where a leakage of water into the oil system cannot be avoided, a water trap consisting of, say, 4 feet of vertical 2-inch pipe with a 1-inch drain cock at the bottom, and fitted to the bottom oil tank or main oil-return pipe has been found of great service. The water, circulating with the oil, will separate from it and drain into the trap; once there, it cannot mix with the oil again. This water trap should be drained twice every 24 hours, letting the water and sludge run until clear oil appears.

The continuous circulation of oil in the system results in a final "breakdown" of the oil itself, due to the action of heat, moisture, and air. The evidences of this breakdown are, increase in viscosity and gravity, the development of considerable acidity, and the deposit of sludge or sediment. The length of service of an oil and the character of the breakdown are dependent upon its quality. A high-grade oil, under normal conditions, will give good service for 10,000 working hours at least; but under severe and very unfavorable working conditions, for only 3,000 working hours at the most.

A sample of "broken-down" oil, when heated, will separate into three distinct layers: At the top, clear oil; at the bottom, clear or somewhat cloudy water; between the two a slimy mixture composed of a number of indeterminate elements. This slime represents the "broken-down" oil, and may be due to its unsuitability or imperfect manufacture, or to some chemical or electrical action on the oil while in service.

"Broken-down" oil accumulates in the most dangerous places, namely in the pipes which conduct the oil from the distributing pipe into the main bearings. Partial stoppage of the pipes may result. This oil also accumulates, as a slime, on the water cooling coils in the oil cooler, thereby decreasing the efficiency of the cooler; the circulating oil assumes a temperature higher than the normal, which in extreme cases greatly impairs the life.

When starting up a new turbine for the first time, there are always present in the circulating system impurities, such as cotton waste, rust, sand and dirt, packing material, etc. It is therefore good practice to run the turbine for 1 or 2 weeks, then remove the entire supply of oil from the system and recharge with new oil. The oil removed should be allowed to rest in a large tank to separate it from the impurities.

After a turbine starts running, the temperature of the oil gradually increases and finally becomes constant. This is the case of a small turbine, after 4 hours continuous running, and of a large turbine after nearly a whole day's continuous running.

The temperatures are important in judging the efficiency of the lubrication and cooling, and it is a wise precaution to take temperature records every half hour, or every hour, as follows: (*a*) Temperature of each main bearing (or of the oil return from each main bearing). (*b*) Temperature of the oil before entering oil cooler. (*c*) Temperature of the oil after leaving the cooler. (*d*) Temperature of the cooling water entering the cooler. (*e*) Temperature of the cooling water leaving the cooler. If any abnormal conditions arise in one of the bearings or in the cooler, the temperature records will immediately locate the trouble. By introducing high-grade oils where cheaper grades have been in use, a reduction in temperature above that of the room of more than 20 per cent. has been obtained, all other conditions being the same.

As shown in the preceding paragraphs, the oil used in horizontal steam turbines is subjected to severe strain. The general belief among engineers in the past has been that petroleum lubricating oils are indestructible. This is very nearly true in practice, where the older methods of lubrication are employed. Where, however, the turbine is lubricated by means of a circulating system in which the oil is forced to the bearings under pressure, thence collected, filtered, cooled, and repeatedly returned to undergo the same severe service, deposits may form due to the breaking down of some portions of the oil from the following causes: (*a*) Water; (*b*) solid impurities; (*c*) electric action; (*d*) addition of new oil.

(*a*) *Water*.—Water has an emulsifying effect on the oil, particularly if the water contains impurities. Where considerable quantities of water leak into the system and emulsification takes place, the mixture

becomes yellow or brownish-yellow in color. If a sample is taken out and heated, it will separate into clean oil at the top, more or less milky water at the bottom, and a spongy sludge separating the two. The clean oil will be found darker in color than the original, with a strong characteristic odor. It will have a higher viscosity and will contain a percentage of petroleum acids as a result of the breaking down of the oil from oxidation.

(*b*) *Solid Impurities.*—Owing to the high temperature at which the oil passes through the circulating system, the oxidizing effect of impurities—such as iron oxides, dust and dirt, etc.—is considerable, particularly where ordinary oils are in use. There is a quick darkening of the color of the oil, a considerable increase in viscosity, the production of a large percentage of petroleum acids and the breaking down of the oil from oxidation. The oil in this condition smells "burnt" and throws down a slimy deposit which often lodges in the oil cooler.

(*c*) *Electric Action.*—If there is a leakage of current from a direct-current generator, the current will pass through the shaft down through one of the main bearings, through the bed-plate, and up through another main bearing back into the shaft. In the case of an alternating-current generator, in which the magnetic field is out of balance, a so-called induced current is produced in the turbine shaft.

In either case, the oil will quickly darken in color, increase in acidity and throw down a deposit which will coat all parts of the turbine with which the oil comes in contact, lodging particularly in the oil cooler. This deposit is of fairly hard, brittle nature, and a dark chocolate color; it is difficult to remove, therefore very objectionable.

The remedy is to insulate one of the generator main bearings completely from the turbine bedplate, including the connections between the oil pipes, and that particular bearing. Such insulation will prevent the formation of such an electrical current, and consequently prevent the formation of a deposit.

(*d*) *Adding New Oil.*—Where practically no water enters the circulating system, and where there is practically no waste or leakage, the oil will, in time, become dark in color with a considerable increase in acidity. In such cases it has been found that when adding new oil a dark deposit is precipitated throughout the system, due to the action of the old oil on the new. Particularly is this the case with heavy oils more than with the lighter grades.

Trouble in air compressors from a lubricating standpoint may arise from any of the following causes: (1) The use of an unsuitable slow acting heavy oil, which means increased power consumed by friction, and probably excessive carbonization. (2) The use of an oil containing unsuitable fixed oils, which cause the development of gummy deposits and excessive friction. (3) The use of an oil with too low a flash point; this is dangerous, and the result obvious. (4) An excessive or irregular feed; this will give the dust, if any, the best chance of accumulating, and choking the valves. (5) Dust entering the air cylinder and accumulating there. (6) Inefficient water cooling, due either to fault in the arrangement or carelessness on the part of the attendant (allowing the water-jacket to get furred up, forgetting to put on the cooling water supply, etc.). Carelessness on the part of the attendants in failing to keep the compressor discharge pipe and receiver clean when deposits, either on account of unsuitable oil or excessive amount of dust, have been formed.

With coal cutters the wear and tear is great, due to the rough conditions under which they usually operate. The men operating them do not, as a rule, give the attention to lubrication that is really most necessary in order to prevent too frequent breakdowns. These machines require two different oils, one for the gear case, which should be a heavy oil not liable to leak easily from the gear case, and another oil for the motor bearings.

Where machinery works in a dusty atmosphere, dust is apt to cling to the oil, and for this reason ring oiling bearings have only been a qualified success. The oil wells must be cleaned frequently in order that the oil may render satisfactory service. Oil syphons are easily choked by the dust, but glass-bottle needle oilers have proved very reliable and satisfactory in a good many cases. They are, however, liable to be broken off and smashed.

Satisfactory lubrication of mine-car bearings is important, as upon that depends, very frequently, the output of the colliery. This subject is very complicated, and cannot be treated adequately in a few words.

Hand oiling with oil or grease is wasteful, and is rapidly going out of use. All the bearings of the cars should be of the same design at the same mine, and arranged so that they can be lubricated automatically.

If automatic oilers are used, they should be designed so as to prevent as far as possible dirt, coal dust, and water from entering the oil container. They should be easy of adjustment, and be able to work for a long period without being cleaned. They must be rugged and not easily damaged or broken by a car jumping the track, or by the haulage ropes, which in many cases have pulled oilers to pieces.

Food Prices

For the eight years, 1907 to 1914, considering all food combined, the highest price was reached in 1914, while the lowest price prevailed in 1907. This, however, is not true of each article. Flour, for instance, was 5.3 per cent. higher in 1909 than in 1914. Sugar, which reached a remarkably high point, 145.3 per cent., in August, 1914, was 7.9 per cent. lower for the year 1914 than for the year 1911, and was also lower for the year 1914 than for the years 1910 and 1912. All meats were higher in 1914 than in any of the 7 preceding years.

WITH THE EDITORS

The First-Aid Number

FOR some years The Colliery Engineer has issued a special first-aid number grouping the first-aid events from all parts of the country. This has met the approval of those interested in the movement, since it gives every one a chance to learn what all the others are doing in the same line, and also it is a revelation to the public at large as to the widespread interest in first aid throughout the mining industry.

In accordance with this custom, the November number of The Colliery Engineer will be the "First-Aid Number," and those connected with the first-aid events, especially where our representatives are not able to attend, are invited to send reports and photographs to the editor, so that all may have due credit for their efforts in the cause.

Dust Explosions

THERE appears on another page an abstract of an address by David J. Price, of the Bureau of Chemistry, United States Department of Agriculture, on Cereal-Dust Explosions. This is published in a paper devoted to the coal industry because it is in this industry that the most terrible results of dust explosions have been felt.

It is only a few years since the possibility of the explosion of combustible dusts has been recognized. Some of the earliest investigations were induced by a disastrous flour-mill explosion, and demonstrated that an explosion of fine cereal dust was possible. Even after this the idea that coal dust could be exploded met with much opposition.

Really the cereal dusts and others, such as straw dust are not so very different from coal dust in behavior or in nature. Both are vegetable substances, combustible, capable of yielding volatile combustible matter on heating, and of being suspended in the air. Anything which can be learned by study of cereal dusts may very probably prove of value in the study of coal-dust explosions.

Shooting Off the Solid

THE miner of bituminous coal who shoots off the solid usually, in time, suffers for it. Unfortunately, he is not always alone in paying the penalty for wrong practice, but, in many cases, injury and death are inflicted on many of his fellow workers.

If the mine laws of a state permit shooting off the solid, both miners and mine officials should unite in getting the laws changed. If any organization condones the practice or gives support to one of its members who may be disciplined for such an act, that organization, instead of being wholly beneficial to mine workers is, to this extent, inimical to them.

Shooting off the solid is wrong. It may make mining a little cheaper in some cases, but it decreases the value of the product, and injures the roof. Above all, it is not safe, and no practice which adds to the dangers of coal mining is right.

Mr. Walsh and Colorado

THE recent labor trouble in the Colorado coal fields has been investigated, and Mr. Walsh, chairman of the Commission, has decided that the Rockefellers are very reprehensible persons. Not only has he so decided, after what doubtless appears to him sufficient consideration, but he has hastened to put his opinion before the public and it has been printed as if it were the opinion of the whole Commission, though it was not.

Doubtless there are two sides, at least, to the Colorado matter, and nobody knows how many more. But the reports of Mr. Walsh's behavior fail to show much desire to see more than one side. In fact, it looks very much as if the chairman of the Commission had decided in advance of the investigation that there was only one side worth looking for.

It is a pity that Mr. Walsh has not grown broader as he has grown older. Some few years ago in Kansas City he gave promise of becoming one of the nation's big men—big in mentality and broad in the handling of important legal and industrial problems. But, his actions as an investigator and his published opinions indicate that he is not broad enough to see more than one side of a great subject. We need larger men to deal with such things as the Colorado situation, men of wide views, broad enough to see all sides of things, men who are impartial and honest with that integrity of intellect which goes beyond mere business honesty. A judge was needed, but Mr. Walsh showed himself only a prosecutor.

There has been trouble enough between employers and workmen. Every one who knows coal operators knows that most of them would rather be fair than not, and would rather help the laborer than oppress him. Most mine workers, too, like most other workmen, would rather be fair than not. We do not so much need to know who is wrong, so that he can be made the object of punishment and hatred, as we need to know just how things can practically be made better, how something of the old antagon-

ism between capital and labor can be removed and that cooperation instituted which will put an end to misunderstandings and labor wars.

Reformers make plans and wonder why they do not work. Investigators look at conditions and see that they are wrong. But, there is a wonderful inertia about human society and changes come slowly. The old antipathies and misunderstandings persist. The remolding of society is slow work, but it proceeds. Modern business with its unprecedented combinations has proved one thing, that cooperation is better than competition, and in the end strife between capital and labor must give way to cooperation, just as certainly as competition in the business world is being superseded by combination.

Meeting of Pa. Anthracite Section of the A.I.M.E.

One of the largest meetings ever held by a section of the American Institute of Mining Engineers was that at Lansford, Pa., on June 11. One hundred eighty-six people availed themselves of the opportunity to inspect the plants of the Lehigh Coal and Navigation Co. The plants visited were:

The Hauto power plant whose present capacity is 30,000 kilowatts and the ultimate capacity 100,000 kilowatts. Current is generated at 25 cycles, 11,000—110,000 volts. The generators are General Electric 10,000-kilowatt driven by Curtis condensing turbines.

Hauto washery which has a daily capacity of 1,500 tons.

Bear Creek dam of the Panther Valley Water Co. A reinforced-concrete, hollow-buttress dam of 70,000,000 gallons capacity.

Greenwood colliery. Here the loaded car is bumped from the cage by an empty one, runs down grade to a chain hoist which raises it to a steam-driven rotary dump from which it goes by gravity to the shaft house, where it is carried by a steam-actuated transfer truck to a position in front of either cage and runs to the cage by gravity. One great advantage of the rotary dump is the fact that it makes the use of doors on cars unnecessary. The circular picking table in the tipple was given much attention.

Rahn colliery. This colliery presents an appearance very different from that of the average anthracite surface plant because of the absence of steam machinery, everything being driven by electricity. Hoisting is done by 2,200-volt, 25-cycle, three-phase, slip-ring induction motors with water rheostats. The shaft is 750 feet deep.

Lansford colliery, having an annual output of 1,000,000 tons.

A very delightful lunch was served at the Old Company Club House at Lansford. President Saunders of the Institute gave a short address.

Though the anthracite district is small, the methods and equipment used in different parts are quite diverse. This meeting afforded an unusual opportunity for the inspection of the collieries near Lansford and it was noticeable that the attendance was largely from outside the immediate district.

Education and Welfare at Straight Creek, Kentucky

The Continental Coal Corporation of Kentucky insists on education of the children of its employes. Schools are maintained and if it is found that a miner's children are persistently absent, the miner is given a friendly warning. If he does not heed this, he is told to move on to some camp where attendance of school is not so highly regarded.

This insistence on education comes from General Manager White L. Moss, who believes that children should be in school, that the camp should be attractive, that houses should be screened (have you ever seen a miner's house with a screened porch? It looks good), that gardens should be planted, that the women of the camp should know how to make the houses attractive with curtains and carpets, that moving picture shows should be given, and that everything possible should be done to break the crushing monotony of the life of the isolated mining camp.

The mines of this company are situated on Straight Creek, near Pineville, in the southeastern corner of Kentucky. To a considerable extent they are isolated from the rest of the world, for the high mountains make railroad building difficult and it may be necessary to go 400 or 500 miles, where 60 miles in a straight line would be enough. Wagon roads over the mountains are few and poor, but good roads will soon be built with state aid.

The attitude of Mr. Moss toward the men and women of the camp is shown in his encouragement of gardening. He tells the men to put in their idle days in their gardens. Then he gives them free seeds. He tells them to come up to the stable on an idle day and get a mule to draw a plow, and the company furnishes the plow. The churches are doing a great deal to improve the life of these coal towns. Of course, they are not confining themselves to religious work, but are doing all that they can do to brighten the lives of the people of the coal camps and show them how to live more happily with the things which they have at hand.

The International Engineering Congress

The International Engineering Congress consisting of the five International Engineering Societies has issued a booklet giving a general description of the meetings and excursions which have been planned for the convention September 16–25. A copy of this booklet can be obtained upon request by addressing W. A. Cattell, Secretary, International Engineering Congress, 417 Foxcroft Building, San Francisco, Calif.

Cereal Dust Explosions

Investigations as to Explosibility of Other Dusts Than Coal Dust, and the Causes of Ignition

By David J. Price*

THE study of cereal-dust explosions has been divided into two distinct sections, first, the engineering investigations which have to do with explosions of this kind as they occur in the field, the circumstances and conditions under which they occur, and the chemical side of the problem, which includes the laboratory experimental work.

A total of 19 explosions that have occurred during the past 10 years have been carefully studied and investigated, with a view to determining the causes and circumstances under which they occurred. Of the 19 explosions referred to, 11 have taken place since this work began in August, 1913. Since we have a record of only 8 explosions of this nature from 1905 to 1913, and a larger number in the short period from August, 1913, to the present time, we may reasonably conclude that the recent occurrences have been given special notice and attention since the study began, or that modern advanced and improved mills are experiencing more occurrences of this nature at this time.

It is reported that as a result of these explosions at least 80 men were killed and 125 injured, with a property loss exceeding $2,000,000.

Supposed Causes.—The establishing of a direct cause of a cereal-dust explosion by investigation directly following the occurrence has been found in some cases to be extremely difficult, while in others certain lines were distinctly defined and definite causes could be fairly well determined. The result has been that in a large number of cases the cause could not be definitely established.

Eight explosions were thought to have originated from sparks produced in the machine during the grinding process, one was attributed to production of static electricity, and in the remaining 10 occurrences it was not possible to establish a definite cause of the origin.

Although it has been claimed that sparks produced by foreign matter in the grain fed to the grinders might not possibly be sufficient to ignite the dust, the evidence in the majority of cases referred to was conclusive as to this particular cause. In order to definitely determine the relation of the sparks produced in this manner and a suspended dust cloud, an experimental mill has already been erected at Pennsylvania State College.

It is not possible to state at this time what effect a high ash content has upon the inflammability of "cereal dusts," for no work has yet been done along this line; but it has already been found that elevator dusts with as high as 16 per cent. of ash are very inflammable and develop high pressures on ignition.

From the investigations already conducted relative to the causes of cereal-dust explosions that have occurred in recent years in this country and abroad the following causes may be advanced:

1. Introduction of foreign materials into grinding machines.
2. Use of open lights or naked flames, such as oil lamps, torches, gas jets, lanterns, candles, matches, etc.
3. Property fires.
4. Electric sparks from motors, fuses, switches, lighting systems.
5. Static electricity produced by friction of pulleys and belts, machinery parts, grinding machines, revolving reels, etc.

The first four causes given may possibly be generally accepted but the advancement of the last cause, namely, "static electricity" has opened, as it were, a new field.

In September, 1913, on a dry frosty morning in early fall two slight explosions occurred in separate plants in Western New York, at a time when the feed had been shut off from certain grinding machines. The occurrences took place after considerable lapse in time after the stream of grain had stopped entering the machines. The possibility of "static electricity" being produced by the operation of the revolving plates of a machine suggested itself in a very preliminary way at the time of these occurrences.

Although up to that time experiments had not been conducted to determine whether cereal dusts could be ignited in this manner, it was found by experiment that sufficient static electricity could be produced by friction of a very small pulley and belt to readily ignite natural gas. It was learned at this time that a milling company in the South, engaged in grinding cotton-seed cake into meal, after experiencing a series of explosions, had prevented a repetition of previous occurrences, by grounding the grinding machines, by means of a wire connected to a rod driven in the ground nearby. This confirmed the original theory and indicated the practical success of a grinding device of this kind.

The possibility of static electricity as a source of cereal-dust ignition was very clearly established by an explosion in the dextrine department of a starch factory in one of the Eastern States in September, 1914. The origin of the explosion was traced to the production of static electricity by friction of particles of dextrine on 80-mesh brass gauze surrounding a revolving reel. This reel was only revolving at the rate of 16 revolutions per minute at the time of the explosion.

It is of very great interest to note in connection with this explosion that the company had grounded this reel to an overhead sprinkling system at the time of this explosion. It was found during the investigation, however, that the connection was made from the journal box, and that a heavy film of fresh oil surrounded the shaft. This was thought to have served to insulate the shaft and allow

*Engineer Bureau of Chemistry, U. S. Department of Agriculture. Abstract of address before convention of Fraternity of Operative Millers of America, Cincinnati, Ohio, May 26, 1915.

the "static" to accumulate within the reel until there was sufficient charge to ignite the dextrine dust.

It has recently been found by an English scientist that if a cloud of dust is blown against an insulated conductor (a wire for instance) the wire becomes charged with electricity, and under certain conditions may become so highly charged as to give off sparks.

Nature of a Dust Explosion.—It has been difficult for many to understand in what manner a dust explosion can occur without the presence of inflammable gas at the time of ignition. We may be able to simplify the explanation by stating that we might try for some time with great difficulty to burn a block of wood with a lighted match. If we take a knife and chip the block the shavings will ignite more quickly. We might make excelsior and find it would ignite still more readily, and so on by gradual reduction to a degree of fineness until dust is produced, when we find that the mass will burn rapidly when in suspension and diffusion with air.

The predominating factor which determines the inflammability of a dust and the action of a dust explosion has not been determined. A number of theories have been advanced, including the amount of volatile matter in the various dusts, together with the percentage of moisture and ash; the rate, or ease, of oxidation and the degree of fineness of the dust. All these have no doubt a marked relation to the action and nature of a dust explosion, and are at present receiving careful attention by the chemists experimenting along this line.

Explosive Mixtures of Dust and Air. Since experiments have shown that the cereal dusts will ignite and propagate a flame, it will be of interest to consider the question of the amount of dust necessary to propagate a flame. In some of the experiments the dust was diffused in the proportion of .035 ounce per cubic foot of air space and high pressures developed with the mixture. To obtain the same proportion of dust and air, producing a mixture as inflammable as used in these experiments, it would be necessary to have only about 10 pounds of the dust in a closed room 10 ft.×30 ft.×15 ft.

It is interesting to note at this time that following the explosion in Minnesota in 1878, Profs. Peck and Peckham found that 2 ounces of flour dust diffused with 2 cubic feet of air, when ignited in a box with flame, would produce an explosion sufficient to lift two men standing on the cover. It has been calculated that a sack of flour suspended as dust in 4,000 cubic feet of air (a room 20×20×10) when ignited would generate sufficient force to throw 2,500 tons 100 feet high.

Explosions have been produced at the Pittsburg Testing Station of the Bureau of Mines when there was only .032 ounce of coal dust suspended in each cubic foot of air, or 1 pound in 500 cubic feet. In order to produce combustion it takes all of the oxygen in 1 cubic foot of air to completely burn .123 ounce of the dust used. In France ignition was obtained in one instance with as low a weight as .023 ounce of coal dust per cubic foot, while at the German Testing Station, ignitions have been obtained when .04 ounce of coal dust was suspended in 1 cubic foot of air.

Preliminary experiments have shown that many cereal dusts have relatively a lower ignition temperature and produce higher pressures than the coal dusts. We might therefore conclude that the explosive limits would be lower with cereal dusts than the figures given for coal dust.

Ash in Coal

According to the Chief Engineer of the Commonwealth Edison Co., coal carrying 40 per cent. ash has no value. Every per cent. ash in coal lessens the number of heat units, first by not carrying heat units, and second by absorbing heat units. Few seem to consider that until a body obtains a uniform temperature it continues to absorb heat. A piece of coal must reach the same temperature inside as outside before it radiates heat most effectively.

PERSONALS

The Carbon Coal Co., La Salle, Ill., has reelected R. B. Joy, president; F. W. Dennis, treasurer; and H. S. Hazen, secretary and general manager.

Dan S. Girard has resigned his connection as traffic inspector and car accountant for the Consolidation Coal Co. and has entered into salesmanship relations with the Blue Ash Coal Co.

A. G. Edwards was elected to the Board of Directors, at the recent annual meeting of the Pennsylvania C. & C. Corporation, succeeding Everett Warren, resigned.

Manager L. W. McKown, of the Clark C. & C. Co., at Davenport, Iowa, has resigned and will travel for the Taylor Coal Co., of Chicago. His headquarters will be at Davenport, as heretofore.

Kingdon Gould, a son of George J. Gould, handed in his resignation as president of the Western Coal and Mining Co. at the annual meeting, held in St. Louis, and W. J. Jenkins, who was formerly vice-president and general manager, was elected president. Arthur F. Barnes was chosen vice-president to succeed Mr. Jenkins, and the other officers were reelected. The company has 17 mines in Illinois, Missouri, Kansas, and Arkansas and is a subsidiary of the Missouri Pacific Railway.

The St. Bernard Mining Co., at Paducah, Ky., has appointed Joseph Mattison as local manager, succeeding Samuel P. Sturgis.

The H. C. Frick Coke Co. recently announced the following changes among its officials: Thomas H. Doorley, superintendent of the company's plant at Marguerite, has been appointed superintendent of the Lemont plant, succeeding V. D. Callaghan, resigned. E. S. Wolfersberger, of Hecla, has succeeded Mr. Doorley. Robert Ramsay, formerly superintendent at Calumet, Mutual, and United Works, has been appointed to succeed Mr. Wolfersberger. G. W. English has been

promoted from superintendent at Oliphant to Wynn. J. A. Childs, superintendent at Juniata, has also been appointed the superintendent at Bitner.

J. H. Lane, of Uniontown, superintendent of Oliver No. 3 plant of the Oliver & Snyder Steel Co., has been promoted to general superintendent of the three plants of this company, succeeding the late Fred C. Keighley.

The appointment of John Mitchell, former International president of the United Mine Workers, as chairman of the New York State Industrial Commission, was made on May 24 by Governor Whitman. The term of office will be six years at a salary of $8,000.

Certificates have been issued by the Tennessee Mining Department to the following who have satisfactorily passed the examination for foremen of mines: John Pass, of Cardiff; J. A. Tidewell, of Emery Gap; I. S. Montgomery, of Cardiff; A. C. Montgomery, of Harriman; S. J. Ingram; A. M. Derrick; L. Carroll; C. Bolin and S. S. Bledo, of Rockwood.

W. H. Bradford, the Phoenix Coal Co. and the Victor Coal Mining Co. announce the consolidation of the selling and mining departments of those companies to be known as W. H. Bradford & Co., Inc., with offices at Commercial Trust Building, Philadelphia; 42 Broadway, New York; and Snyder Building, Somerset, Pa. L. G. McCrum has been appointed general manager of mines.

The Crystal Block Coal Co. has moved its main office from Gary to Welch, W. Va.

John R. Hoffman, for 30 years mining engineer for the Philadelphia & Reading Coal and Iron Co. at Pottsville, Pa., has resigned his position. Mr. Hoffman has opened an office at Pottsville as consulting engineer.

The Pennsy Coal Co., of Franklin, Pa., recently elected officers and directors as follows: President, George C. Miller; vice-president, D. D. Mallory; secretary, J. B. Moorhead; general manager and treasurer George P. Cronk. Directors: George C. Miller, William Miller, C. A. Miller, D. D. Mallory, George P. Cronk, and J. B. Moorhead.

The governor of Tennessee has appointed Robert A. Shiflet as chief mine inspector of that state, succeeding George Sylvester.

A. E. Thompson, formerly mine inspector for the Victor-American Fuel Co., at Hastings, Colo., has been appointed to the position of deputy state coal mine inspector of Colorado.

Governor Hatfield, of West Virginia, has reappointed Earl Henry as Chief of the Department of Mines. Following his appointment Mr. Henry announced the appointment of three additional mine inspectors as provided for by the new mining code of that state. The men appointed were J. G. Vaughan, Charleston; Clarence N. Orr, Kingwood; Samuel McMahan, Wellsburg.

The Anthracite Mine Inspectors examining board appointed by the Schuylkill County Court at Pottsville, Pa., announced the result of their examinations on June 5. The present inspectors, P. C. Fenton, of Mahanoy City; A. B. Lamb, of Shenandoah; James A. O'Donnell, of Centralia; Benjamin I. Evans, of Mt. Carmel; P. J. Friel, of Shamokin; and Charles P. Price, of Lykens, were again successful. Kiernan Donahoe, at present an inside foreman for the Lehigh Valley Coal Co., was also successful. This means Mr. Donahoe will succeed the late John E. Curran. The seven men will be reelected without opposition.

Richard Krapf, outside foreman at Phoenix Park colliery, of the Philadelphia & Reading Coal and Iron Co., has been named chief coal inspector for Madeira, Hill & Co., with headquarters at Pottsville, Pa. He entered upon his new duties on June 1.

A deal has been closed whereby the property at Moundsville, W. Va., owned and operated by the Mound Coal Co., has become the property of the Mound City Coal Co., of Pittsburg.

Herbert M. Wilson, engineer in charge of the Pittsburg Experiment Station of the United States Bureau of Mines, has resigned from the government service to become the director of a newly-formed organization to be known as the Coal Mine Insurance Association. It is a combination of ten American and British insurance companies that have associated themselves for the joint underwriting of coal-mine accident insurance.

From the Pottsville, Pa., headquarters of the Philadelphia & Reading Coal and Iron Co., these mine promotions were announced: John Paul, outside foreman at Pine Knot, to superintendent of the collieries of the Minersville district; Elmer Artz, outside foreman at Otto colliery, transferred to Pine Knot; John Withelder, assistant foreman at Otto, advanced to foreman.

M. Scollard, of Brazil, Ind., has been appointed inspector of mines of that state.

OBITUARY

JAMES CLARK HAYDON

James Clark Haydon, a pioneer anthracite operator, founder of the Jeanesville Iron Works and surviving member of the coal firm of Robinson, Haydon & Co., New York, died at his home in Jeanesville, Pa., May 27, aged 52 years.

A native of Kentucky, Mr. Haydon was educated as a civil engineer and began practicing his profession at Rockport, Pa., when a young man. He took hold of the Jeanesville mines in 1864, when the original lease granted to William Milnes in 1847 expired, and with Francis Robinson, organized the Spring Mountain Coal Co., to carry on the operations. The Lehigh Valley Coal Co. bought the property in 1884, and upon the expiration of the lease in the late '90s assumed the operation of the colliery.

In 1868 the Spring Mountain Coal Co. bought a machine shop located at Beaver Meadow and moved it to Jeanesville, this forming the nucleus of the Jeanesville Iron Works, now a large manufacturer of mining machinery and other material. Mr. Haydon disposed of his interest in the concern some time ago.

Mr. Haydon was one of the original stockholders of The Colliery Engineer Co., now the International Textbook Co., and throughout his life remained one of The Colliery Engineer's staunchest friends.

REESE TASKER

Reese Tasker, general mining superintendent of the Philadelphia & Reading Coal and Iron Co., died on May 31, 1915, at his home in Pottsville, Pa.

Mr. Tasker was born in Glen Neath, Glamorganshire, South Wales, September 29, 1846. In his early boyhood he worked in and about the mines of Wales and when 15 years of age came to America, where he was employed at Nanticoke, and worked as a contract miner, later becoming fire boss at Bear Run colliery at St. Nicholas, Schuylkill County, Pa.

His first position with the Philadelphia & Reading Coal and Iron Co. was as fire boss in the St. Nicholas colliery. He was mine foreman in that district at the time of the opening of the now famous Maple Hill colliery and superintended much of the work. Mr. Tasker was made district superintendent April 1, 1893, with headquarters at St. Nicholas, but on December 1 of that year he was transferred to the Gilberton district. On March 1, 1897, he was made division superintendent at Mahanoy City to succeed the late John Skeath, and on December 1, 1903, he became assistant mining superintendent with headquarters at Pottsville, assisting John Veith. Upon the retirement of Mr. Veith on January 1, 1905, Mr. Tasker became mining superintendent.

Mr. Tasker's early education was exceedingly limited, but by careful reading and home study he made himself one of the best informed practical mine officials in the anthracite region, and won every promotion through personal merit. Many of the older readers of The Colliery Engineer will recollect his frequent contributions to the Correspondence Department of this journal, nearly 30 years ago, which were invariably signed "Reese Tasker, Fireboss."

As a token of respect nearly every colliery in the Reading system was

Reese Tasker

closed on the day of his burial, June 3. He was a prominent Mason, being a member of the Mahanoy City Blue Lodge, Chapter, and Commandery, and the Rajah Temple of the Shrine at Reading, Pa.

JOHN BIRKINBINE

John Birkinbine, a prominent mining and mechanical engineer and former president of the American Institute of Mining Engineers, died recently at his home in Cynwyd, Pa. He was called as an iron ore expert in the recent trial of the Government dissolution suit against the Steel Corporation. He was connected with the United States Geological Survey and made reports on iron ore for the eleventh and twelfth census. He was the author of the chapters on "Iron Ore" and "Mining Operations" and of "Beneficiating Iron Ores" in the A, B, C of Iron and Steel, just published by the *Iron Trade Review*. He also had been prominent as a hydraulic engineer with special reference to power installations at Niagara Falls.

JOHN W. REID

Superintendent John W. Reid, 57 years of age and for 44 years in the employ of the Pennsylvania Coal Co., died on June 5 at Scranton, Pa., of acute indigestion.

Mr. Reid was a practical mining man. He started as a door boy and gradually worked his way up to the position of superintendent of the Old Forge district, to which position he was promoted several years ago.

HENRY C. WICKHAM

Henry C. Wickham, pioneer coal miner, born in Ireland, March 14, 1846, died recently at his home in Philadelphia. Mr. Wickham went to the Connellsville region in 1873 as superintendent of the Wheeler coke plant. From that time on up until within the past few years he had been active in coke interests in one way or another.

Testing V-Notch Meters

The measurement of water has become a subject of great interest to a large number of people. The feedwater meter is a sort of cash register for the coal pile, since it keeps a record of the returns in amount of water evaporated for the expenditure for fuel. When the evaporation is low, the owner or operator will naturally look for the cause, as an inferior or unsuitable fuel, defective grates, leaky boiler settings, broken down baffles, soot and scale on the tubes, improper methods of firing, insufficient or improperly handled draft, etc., and as these conditions are improved one by one, the feedwater meter records the simultaneous improvement in evaporation, establishing a standard which acts as a constant stimulus and incentive to effort on the part of the boiler-room force. In other words, although the owner or managing engineer cannot watch everybody and everything, the feedwater meter can do it for him, so far as the performance of the boiler is concerned. These facts are from a leaflet "Testing V-Notch Meters," by the Harrison Safety Boiler Works.

THE LETTER BOX

Readers are invited to ask or answer any question pertaining to mining, or to express their views on mining subjects in this department. All communications must be accompanied by the name and address of the writer—not necessarily for publication.

The editors are not responsible for views expressed by correspondents.

Mine Management

Editor The Colliery Engineer:

SIR:—In answer to the Greensburg reader asking how to develop a mine, it has been my experience that the opening of a gaseous mine should be planned to supply a large quantity of air to the several districts of the mine. The general plan should include at least the triple-entry system of mine roadways, the center entry being made the intake airway and the main haulage road, and the side entries the return airways for each side of the mine. The ventilation should be arranged in separate districts, each district taking its air from the main intake, and discharging it into the main return.

Overcasts should be used in place of doors wherever practicable. This avoids the carelessness of doors being left open. The air should be distributed in quantities to comply with the law. The velocity of the air should be able to sweep away the smoke and gases accumulating in each district. Strict regulations should be enforced throughout the mines.

The working face, together with the adjacent sides, roof and bottom, should be sprinkled thoroughly before a shot is fired. Experienced shot firers should do the blasting and use permissible explosives.

Haulage roads and traveling ways should be cleaned regularly, and all accumulations of dust avoided. It is most important to use dust-proof cars for hauling the coal in the mine, and it is also necessary to install an efficient spraying or watering system.

Approved safety lamps should be used and strict regulations enforced regarding misuse or careless handling of the lamps. No person should be entrusted with a safety lamp until he gives satisfactory evidence to the mine foreman that he understands how it should be handled and under what conditions it becomes unsafe. There should be a proper system of distributing and receiving safety lamps at the beginning and close of each shift.

At the surface, efficient ventilation apparatus should be installed. This should consist of a modern, improved type of centrifugal fan, to be run on the exhaust system, but constructed so that it could be used as a blow fan in case of emergency. The mine should be equipped throughout with efficient machinery, tipple, and dumps. The necessary officials are superintendent, mine foreman, one assistant mine foreman, two fire bosses, one boss driver, and one boss roadman.

JAMES F. MCCLUSKEY
Cecil, Pa.

A New Fraternity

A professional fraternity; Sigma Gamma Epsilon, devoted to the allied interests of mining, geology, and metallurgy has been founded at the University of Kansas.

It is proposed to establish chapters in the departments of geology, mining, and metallurgy in the leading universities and scientific schools of the United States and Canada.

At present there is no such society extant. It is hoped the organization of such a professional fraternity among undergraduate students will promote a greater interest in the broad field of these allied sciences. The social as well as the scientific advancement of its members is provided for.

The charter members of the society are: Dr. E. Haworth, State Geologist, Professor of Geology; Dr. W. K. Twenhofel, Associate Professor Geology and Paleontology; R. A. Reynolds; H. E. Crum; H. R. Brown; W. E. Rohrer; C. B. Carpenter; C. L. Allen; S. F. Kelly; G. B. Sammons.

Mine Explosion

The Stonega Coke and Coal Co., of Big Stone Gap, Va., will hold a first-aid contest in July 2. In connection with the contest will be a demonstration of the explosibility of coal dust by black powder. An explosion gallery similar to that described in the June issue of THE COLLIERY ENGINEER has been erected for the experiment.

Classification of Technical Literature

Delegates from about twenty national technical and scientific societies met in the United Engineering Society Building, 29 West 39th Street, New York City, on May 21, 1915, to perfect a permanent organization, the purpose being to prepare a classification of the literature of applied science which might be generally accepted and adopted by these and other organizations.

By request, Mr. W. P. Cutter, the librarian of the Engineering Societies' library, and a delegate from the American Institute of Mining Engineers, read a paper on "The Classification of Applied Science," in which, after describing the existing classifications, of one of which he is the author, stated that, in his opinion, no one of these, although having excellent features, was complete and satisfactory enough to be worthy of general adoption. He outlined a plan whereby a central office could collate all the existing

classifications, and, with the help of specialists in the various national societies interested, might compile a general system, which although perhaps not absolutely perfect, might meet with general acceptance and adoption.

The delegates present expressed most hearty and enthusiastic personal interest in any system which might be worthy of general adoption; they could, of course, not promise at this early date, anything more than moral support to the idea, reserving for themselves and for their societies the right to thoroughly examine any system that might be evolved before recommending its adoption.

BOOK REVIEW

A review of the latest books on Mining and related subjects

The West Virginia Geological Survey, of Morgantown, W. Va., has issued a new publication entitled "Detailed Report on Boone County," by C. E. Krebs, issued under date of May 25, 1915, containing 648 pages, and illustrated with 43 halftone plates and three figures of zinc etchings in the text; also a case of two maps covering the topography and geology of the entire area in one sheet. The soil map is attached to the accompanying Soil Report. In addition to the detailed description and revision of all the rich coal beds and other geologic formation exposed in these counties, the geologic map gives the structure, contours, and outcrops, of the celebrated No. 2 gas coal, as also that of several other valuable coal beds, along with many new sections, analyses, etc. Price, with case of maps, delivery charges paid by the Survey, $2, but for combination price with other publications, see general circular of publications. Extra copies of geologic map, $1 each, and of the topographic map, 50 cents each.

Technical Paper 101, "Permissible Explosion-Proof Electric Motors for Mines; Conditions and Requirements for Test and Approval," has just been issued by the United States Bureau of Mines. The author is H. H. Clark, electrical engineer.

The Bureau in this paper has applied the term "explosion-proof" to motors constructed so as to prevent the ignition of gas surrounding the motor by any sparks, flashes, or explosions of gas or of gas and coal dust occurring within the motor casing.

Before it undertook to establish a list of permissible motors the Bureau made a large number of preliminary tests. No motors were approved as a result of this preliminary investigation, for none of the motors tested was considered to possess the characteristics of permissibility. As a direct result of these preliminary tests, however, it was decided to make tests to establish a list of permissible explosion-proof motors, and Schedule 2, "Fees for Testing Explosion-Proof Motors," was issued. This schedule gave the general conditions under which motors could be submitted for test and the fees to be charged for making such tests.

Mechanical Engineer's Reference Book, by Henry H. Suplee. Published by J. B. Lippincott Co., Washington Square, Philadelphia. $5 net.

The work contains 919 pages and hundreds of illustrations. It is furnished with a complete index of about 44 pages. The volume is of pocket size and bound in limp leather; it is also supplied with a thumb index. The author of this work is a member of the American Society of Mechanical Engineers and is also the translator and editor of the English edition of Reuleaux's Constructor, a standard work on machine design. The title of the book suggests the nature of its contents; it is devoted principally to the presentation of tables, formulas, and reference data for mechanical engineers. The author states that it is purposely full in the portions relating to machine design and to such information as will render it useful in the drawing room and in the designing department. In this connection only those rules and formulas have been given which in the judgment of the author are most generally applicable. A number of the tables have been presented in both British and metric units. This work is intended to be a successor to the well-known pocketbook by the late John W. Nystrom; the plates and stock of that valuable work having been destroyed by fire, certain of the information therein contained has been utilized with modifications by Mr. Suplee. The thumb index gives the heads taken up in the handbook which are as follows: Mathematics, Mechanics, Materials of Engineering, Strength of Materials, Machine Design, Heat, Air, Water, Fuel, Steam, Steam Boilers, Steam Engines, Internal Combustion Motors, Electric Power, and Cost of Power.

The present edition is the fourth and contains an appendix of 40 pages. This comprises much useful information essential to the engineer.

Bulletin No. 12, Illinois Coal Mining Investigations, Urbana, Ill., describes coal mining practice in District IV and is written by S. O. Andros, who performed the necessary field work in connection with Prof C. M. Young and Dr. J. J. Rutledge.

The district includes all the mines in seam No. 5 of the Illinois Geological Survey correlation operating in Cass, De Witt, Fulton, Knox, Logan, Macon, Mason, McLean, Menard, Peoria, Sangamon, Schuyler, Tazewell, and Woodford counties.

The average thickness of the seam is 4 feet 8 inches. It has a uniform appearance from top to bottom and the coal is hard and massive. The roof has a black sheet of shale locally called slate, while the cap rock in most of the mines is limestone, although in a few, there is a fine-grain micaceous sandstone. In many places of the district the coal sticks to the roof and is separated from it with difficulty. There are other cases where it is necessary for about 1 inch of coal to be left up to protect the roof shale from the moisture in the air. The floor in most cases is of a dark gray fireclay which heaves badly when wet.

The mines vary in depth from 60 to 570 feet, but all except two, are less than 300 feet deep. In all closed workings the 235 mines are worked on the room-and-pillar system, four mines are operated on the longwall system. There is one stripping. The bulletin goes on discussing in detail the mining practice, ventilation, blasting, timbering, haulage, hoisting, and preparation of the coal. It contains 23 illustrations showing every phase of mining discussed.

Power is usually obtained by burned slack under the steam boilers. The largest installation of any mine examined is 750 horsepower.

For the year ending June 30, 1912, 8,523,903 tons of coal were produced in this district, which is approximately 15 per cent. of the state output.

Soil Survey of Logan and Mingo Counties, W. Va. By W. J. Latimer. The Department of Agriculture has just published a bulletin describing the soil in these two important coal counties of West Virginia. The physical, geological, and climatical conditions are analyzed together with a comprehensive description of the plant and animal life in that section. To the residents of those counties this bulletin is both interesting and instructive as well as adding to the general knowledge of the nation at large.

Petroleum Industry of California. Bulletin 69, 500 pages, illustrated. Price $2. Issued by the California State Mining Bureau.

In preparing this report a thorough review of the oil industry was made and all of the many phases of the subject are for the first time presented in a single publication. It is believed that the information will be valuable to all persons who are interested in any manner in the oil business of the state.

The extent and productiveness of oil land in California is outlined. The cost of drilling wells and recovering the oil is gone into very thoroughly. The financial or business aspect of the industry has received special attention.

The maps of the developed fields, and many prospective areas, are bound in a most convenient form and clearly show all the wells, pipe lines, and land ownership. This feature is of the greatest value to every oil operator or other person even slightly interested in oil lands.

In addition to the bulletin, a map folio accompanies the report. This folio is highly interesting. It contains columnar correlation of the geologic formation of the California coast range, showing the oil horizon and characteristic fossils. Photographs are shown of fossils characteristic of California formation. Geologic sections of portions of Los Angeles, Orange, Mantura, Monterey, San Luis Obispo, and Kern counties, are shown. Geologic cross-sections are shown through several oil producing regions in Monterey and San Luis Obispo. Maps covering the Coalinga oil field, Kern River, McKittrick and North Midway, South Midway and Sunset, Lost Hills, Belbidge, and Devil's Den, Salt Lake, Whittier-Fullerton, and the Santa Maria oil fields, are given.

Interesting drawings are shown of the rotary rigs in use, together with a list of the materials required for each. Another drawing together with necessary bill of material shows the plans for 750,000 barrel oil reservoir with a concrete lining.

Finally, a map of the California oil and gas pipe lines is given. Altogether the publication calls general attention to the fact that a careful consideration of details underlies uniformly successful operations.

PUBLICATIONS RECEIVED

Report of the Canadian Department of Mines. Year 1913, No. 285.

Preliminary Report on the Bituminous Sands of Northern Alberta, No. 281.

State Geological Survey of Georgia, Bulletin 30. Feldspar and Mica Deposits of Georgia.

Report of Mine Rescue Station Commission, Illinois, 1915.

Bulletins of Wisconsin Geological Survey:

A Study of Methods of Mine Valuations and Assessment (Special Reference to Zinc Mines of Wisconsin).

The Polyporaceae of Wisconsin.

Mines and Minerals Resources of Imperial and San Diego Counties, Calif.

The following are bulletins of the United States Geological Survey, Washington, D. C.:

Surface Water Supply of the United States, Part IV, St. Lawrence River Basin, Water Supply Paper No. 354.

Gazetteer of Surface Waters of Iowa, 345–I.

The Coalville Coal Field, Utah, Bulletin 581–E.

Mineral Deposits of Santa Rita and Patagona Mountains, Arizona, Bulletin 582.

Geology and Coal Resources of the North Park, Colorado, Bulletin 597.

Northeastern California and Northwestern Nevada, Bulletin 594.

Results of Spirit Leveling in Idaho, Bulletin 567.

Results of Spirit Leveling in Minnesota, Bulletin 560.

The Production of Sand-Lime Brick, 1914.

The Production of Spelter in the United States, 1914.

The Production of Lead in the United States, 1914.

The Production of Copper in the United States, 1914.

Contributions to Economic Geology, Bulletin 580.

United States Bureau of Mines:

Coal Tar Products, by C. G. Storm, Technical Paper No. 89.

Vapor Pressure of Arsenic Trioxide, by Welch & Dushak, Technical Paper No. 81.

Smelting of Copper Ores in Electrical Furnace, by Lyon & Keeney, Bulletin 81.

Pencil marks can be removed from tracings by wiping them with a cloth dampened with benzine or gasoline. The ink is not affected and the tracing is cleaned and brightened.

Electrical Equipment Rules

Governing the Installation and Operation of Electrical Equipment at Mines of the New River Company

These rules and instructions are intended to supplement the mine law and the posted rules of the company. Should anything in them conflict with the mine law or the rules, the law and the rules must govern and be followed explicitly.

S. A. Scott, General Manager.

The number following each rule shows the relative weight of each rule in rating by the company inspector.

MINING MACHINE WIRING

1. All power circuit mine wiring must be done with approved mine type insulators and pins as specified under the headings Trolley Wire, Pumps, and Mining Machine, 15 feet to 20 feet apart where the roof is low, and where the roof is sufficiently high to permit it, 20 feet to 25 feet apart. 10.

2. The amount of wire in mines must be minimized as much as possible, and where circuits are no longer necessary the wire must be disconnected at once and removed. The practice of leaving wire remain in old breakthroughs, cross-cuts, etc., must be discontinued and old tie-wire, broken bonds, scrap trolley wire, old cables and coils of old wire must be gathered up and kept in an orderly manner where it will not be accessible to every one. All scrap wire, etc., must be disposed of promptly and not allowed to accumulate in quantity. 25.

3. All insulators for hanging machine wire must be similar in size and type to the O. B. No. 10630. 5.

4. Only one wire is to be placed on an insulator, securely tied with at least five turns of wire on each side of the insulator. The tie-wire must be of the same size as the wire being hung, up to size No. 4; when wire of larger size is being hung No. 4 wire must be used. No hay wire or steel wire of any kind shall be used for tie-wire or conductors. 10.

5. Where the wire of a cross-entry or an entry from which rooms are to be turned leaves the main entry, one single pole quick break switch of 200-ampere capacity must be placed on positive side, when tapped to trolley wire and having negative grounded to track. But when tapped to two wire feeder circuit, two single pole switches of 200-ampere capacity each must be used. One switch on positive side and one on negative. 10.

6. The cold or negative wire must be put up and maintained with the same care as positive wire and in no instance thrown down along the entry or placed underneath the road or track. All wires when erected must be put up with care and pulled up snug and taut to remove all kinks and slack and not allowed to touch slate, coal, or timbers; but must be erected and maintained at a safe distance therefrom and not less than six (6) inches apart. The practice of using jumpers, hanging wire on nails, or wedging insulators or cap pieces between wires or between wires and coal, etc., will not be permitted. 10.

7. Under no conditions must live coils be left hanging on rib at end of any circuit; and no wires are permitted to be placed under the track at any point. 10.

8. No rooms are to be wired unless by permission of the company inspector, and then only according to his instructions. Entries must not be wired beyond the last breakthrough, and no wires shall be allowed in old return air-courses, or any other entry or air-course unless it is examined at least once a week. By return air-course, we mean the airway into which the air goes after it has traveled through the different entries of this particular split. 10.

9. Where the wire crosses an entry, whether the top is sand rock or not, it must be shot out of sufficient height to allow the wire being placed so there will be no danger of any person coming in contact with same. Where the height of the roof will permit the wire may be protected by a board placed on either side of the wire, instead of shooting the roof. The wire must not touch the boards but must be thoroughly insulated and well separated from them. 15.

10. The terminal ends of all large wires must be securely anchored and thoroughly insulated with a turnbuckle and strain insulator. The practice of dead ending on wood cross-pieces or posts without the use of an insulator will not be permitted. 15.

11. In all entries where the height of roof and the untrimmed sides do not permit the wires being placed over head, they must be trenched in the rib and protected with a board not less than six (6) inches wide carried on wooden pegs driven in the rib. In wide places when posts are set parallel to the track, wires may be carried on back side of posts with the protection of a six (6) inch board nailed to the posts. 15.

12. All wire joints of No. 2 wire or larger must be made with brass sleeves thoroughly and neatly soldered or with approved connectors, such as Dossart Type A two-way connectors. For smaller size wires use regular Western Union joints with no less than six turns on each side and thoroughly soldered. 5.

13. Where wires go through wooden or brick brattice work or other partitions not exceeding ten (10) inches in thickness, they must be protected with porcelain tubes. The tubes, if in wood partition must be held in place with tape. If in brickwork, they must be cemented so that they cannot be moved. Where partitions, brattice, etc., are built after wires have been erected, split tubes must be used to avoid the cutting of wires. 10.

14. Where wires go through stone brattices exceeding ten (10) inches in thickness the wires must be protected by circular loom conduit. Said conduit to extend 2 or 3 inches through the partition on either side. 10.

15. In wiring all entries where there is sufficient height with good roof, the wire can be placed on roof on chain pillar side of entry. Care must be taken that the positive or hot wire is placed next to the rib, and the negative or cold wire is placed not less than six (6) inches on outside of hot wire. 5.

16. All feeder wires when tapped to trolley wire must be tapped with regular feeder ears similar to O. B. 10346, and in no case must wire be hung loose or wrapped around trolley wire or trolley ears. 5.

17. Machine head cables must have nipples (such as style SS 52, Morgan-Gardner Catalog) soldered on the end of the cables where they enter the machine terminal boards and reels. Long machine cables must have one end soldered to reel; the other end must have spring clamps similar to O. B. 11433 where it fastens to feeder wire. 10.

18. Machines that are provided with safety washers, or lugs, shall not be permitted to run without them. No solid washers allowed, and extra safety washers must be kept with the machine at all times. 10.

19. If a machine is out of commission in the mine and is not to be used for a period of two weeks or more, it must be removed to the outside and kept under cover. 5.

20. The size wire for mining machine wiring must be in accordance with the following table:

550-Volt Circuit

No. Machine	Distance Feet	Size Wire No.
1 Breast machine	2,000	4
2 Breast machines	1,000	4
2 Breast machines	2,000	1
1 Shortwall machine	1,000	4
1 Shortwall machine	2,000	1
2 Shortwall machines	2,000	2-0
2 Shortwall machines	1,000	1

275-Volt Circuit

No. Machine	Distance Feet	Size Wire No.
1 Breast machine	1,000	4
1 Breast machine	2,000	1
2 Breast machines	1,000	1
2 Breast machines	2,000	2-0
1 Shortwall machine	1,000	1
2 Shortwall machines	1,000	2-0
1 Shortwall machine	2,000	2-0
2 Shortwall machines	2,000	4-0

5. Total 200

RULES ON TROLLEY WIRE

21. Trolley wire may be suspended inside the mine on hangers lag screwed to cross timbers or by suitable expansion bolts held in the roof, or where the roof is high, by special hangers carried on pipe driven into roof or rib. The practice of screwing two or more hangers together must be discontinued, and where two or more hangers are in use they must be removed at once. 15.

22. All new trolley wire will be 4-0, of the standard grooved pattern; care must be taken that no kinks, sharp turns, or dents from come-alongs are made in it. 5.

23. Make all splices with twenty (20) inch trolley splice for grooved wire. Do not use common ten (10) inch round wire splice for splicing trolley wire. 5.

24. The center of each hanger must be plumbed seven (7) inches outside the outer edge or rail, and trolley wire must be hung at a uniform height above the rail as nearly as possible. Hangers are to be placed about fifteen (15) feet apart on straight entries in low coal, and twenty-five (25) feet in high coal. Considerable latitude will have to be allowed as no specific rule can be made for distances apart of hangers, but the above is a fair average when wire is erected and maintained properly. On curves the

(Continued on Page 687)

NEW MINING MACHINERY

The Barr Pneumatic Light Forging Hammer

A simple, inexpensive forging hammer has recently been placed upon the market by H. Edsil Barr. The hammer is designed for doing all sorts of miscellaneous light tool dressing, welding, bending, straightening, forming, forging, etc., which are now done at many mine repair shops by hand. The manufacturer claims that the Barr hammer is particularly intended for the varied and miscellaneous work for which the operator would not buy an expensive belt-driven or steam hammer. The pneumatic hammer is free from numerous working parts. It embodies materials that are conducive toward standing the strain of rugged use, such as the semisteel castings, full chrome-vanadium and high-carbon steel forgings, Scott's tool-steel dies, etc.

The hammer consists of a heavy anvil or die block, cast solid and with provisions for bolting down. Cast with the anvil is a heavy box frame or housing, strongly reenforced inside, and supporting the cylinder.

In the cylinder operates the piston which drives the ram or hammer head, and the movement of the ram is controlled entirely by the operator who presses the foot lever seen at the front, thus operating the valve which admits air under pressure to the cylinder.

The valve operation is such that the ram is always clear up when the air is turned on. The blow is struck by pressing the foot lever, and the ram immediately rises upon release of the lever which is held in its upper position by a spring in the front of the anvil. Control of the blow is absolute, and with a few days' use the operator can with entire ease strike either the full stroke maximum blow or shorter and lighter blows. The foot lever works with about the same exertion required to run a sewing machine and it follows the movement of the foot rapidly, permitting striking any

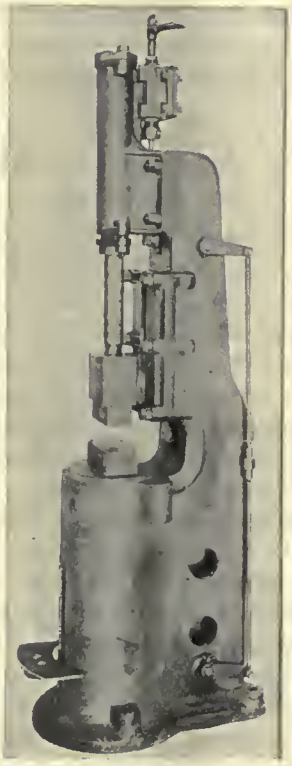

Fig. 1. Pneumatic Hammer

number of blows without fatigue, and in rapid succession. This is the ideal method of operation on small tools and parts, as better opportunity is given for frequently inspecting the forging and there is not the chance of spoiling it as in hammers striking automatically.

No helper is required when the Barr hammer is used, and the blow is so powerful and effective compared with the blow of a sledge that the number of heats are greatly reduced. For plain work one heat is frequently all that is necessary. The saving is apparent, not only in labor and time of forging but in reduced delays, increased production and more dependable and homogeneous forgings. A helper cannot strike modern tool steel hard enough to reduce or draw it rapidly in one heat.

Improved Method of Bagging Coal

The loading of bulk coal has been reduced to a simple matter by the advent of the mechanical wagon loader which has overcome the handicap of ground storage, and brought it up to the efficiency of the pocket. By using an elevator to keep a bagging bin constantly full of coal, the equivalent of bagging from a pocket has been reached.

The new Link-Belt loader consists in all its essential features of an elevating and screening apparatus. The elevator buckets are 16 in. $\times 6\frac{1}{2}$ in. on a double strand of a closed-joint chain, and the screen is of the shaking type set at such an angle that only by vibrating can the coal be made to flow over it. A 2-horsepower motor operates the loader. In actual operation with two men bagging, coal has been bagged at the rate of over 21 tons per hour. The screens are interchangeable for the various sizes of coal from pea to egg, all of which are handled with equal facility.

Efficient Small Air Compressor

The constant demand for higher efficiency and greater economy, and the increasing tendency toward the use of higher steam pressures has led to the development of the small steam-driven, high-speed, air compressor shown in Fig. 2 by the Ingersoll-Rand Co.

"Ingersoll-Rogler" air valves are used. They allow of high speeds,

give high compression efficiency, are almost silent in operation, and are independent of any operating mechanism. Before adopting this valve a thorough test was conducted to determine the life of this type of valve. This test consisted in running a 12-inch stroke compressor

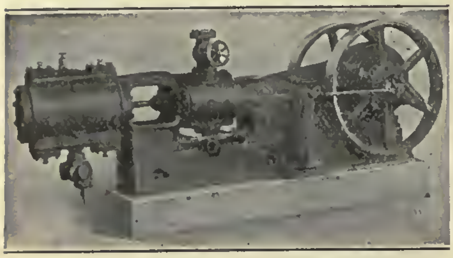

Fig. 2

400 revolutions per minute over a period of 1 year, during which time no valves were broken nor any adjustments required, and in the 2 years in which this valve has been on the market practically no breakage has resulted.

The piston steam valves are balanced. This design permits of higher speeds, high steam pressures and the use of superheated steam, at the same time giving a higher efficiency under ordinary low-pressure steam conditions.

Automatic cut-off control, giving the highest possible steam economy under conditions of varying load or a varying steam pressure is part of the general design. This control is regulated by a centrifugal flywheel governor which acts to shorten or lengthen the stroke of the piston valve, thus changing the cut-off. Furthermore, it is supplemented by an air unloader assuring great economy whilst possessing a high degree of automatism, which is essential in a small compressor designed for severe duty, and generally subject to considerable neglect.

National Tube Co.

At the Panama-Pacific Exposition, the National Tube Co. has two displays of interest. One shows a few comparisons of wrought-iron and steel pipes taken from actual service lines, after use during the same period of time. The results obtained show conclusively that there is little difference in the durability of wrought-iron and steel pipe under like conditions. In the second exhibit there is a specially designed heating system with the idea of conducting actual service tests on alternate lengths of wrought-iron and steel pipe. In order that results may be obtained in a comparatively short time air is injected with hot water prior to its entering the pipe. This will hasten deterioration. It is expected that before the exhibition is over the coils can be taken down and the results displayed.

New Headlight for Mine Locomotives

Mine operators who have long wanted an incandescent mine locomotive headlight to replace costly arc lights and inefficient carbon bulb lamps, will be interested in the new "Golden Glow" mine locomotive headlight recently announced by the Esterline Company, of Indianapolis, in their catalog, No. 364-C.

This light is similar in design to the "Golden Glow" railway headlights which have been so widely adopted in the last year and a half, because of their mirrored glass reflectors and fog penetrating, non-blinding light. Exhaustive service tests of this lamp have preceded its announcement, and the results indicate that mine operators can now obtain equipment which will give long bulb life, reduce maintenance and current expense, and give a non-dazzling, keenly penetrating beam illumination.

The new headlight is really a lamp within a lamp, the interior lamp body carrying a 7-inch mirrored glass reflector and Mazda bulb, so suspended that the constant pounding of mine locomotive service will not break the filament. It is practically dust-tight and water-tight. Miners can work in its beam at close range or at considerable distance with equal ease. In fog or dampness it provides projection not possible with any white light. The current consumption with a "Golden Glow" headlight is reduced from that of a 4-ampere arc light to one-third of an ampere with a 36-watt bulb, or one-fifth of an ampere with a 23-watt bulb.

Portable Electric Drill and Reamer

Although the portable electric reamer shown in Fig. 3 was designed for bridge construction work, it is applicable for coal mines and all shop work.

The motor, which is intended for use on direct-current only, is of the series-wound, four-pole, air-cooled type, and is entirely inclosed. The brush holders are mounted on fiber blocks and the binding posts holding the leads are designed to secure contact by compression springs. This arrangement eliminates the use of nuts and screws, with which there is the possibility of loosening in service and becoming lodged in the motor. Four removable window guards give access to the brushes, thus enabling them to be replaced quickly without removing the cap or disturbing any part of the machine. The switch used is of the quick make-and-break type with a release lever in one of the side handles.

A special type of slip socket is used, which eliminates the drift key

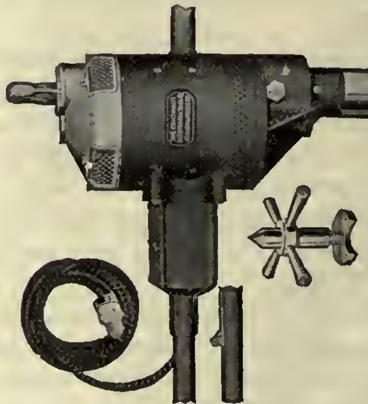

Fig. 3. Electric Drill

and holes in the spindle, and this arrangement is calculated to prevent dirt and grease from lodging in the spindle. Chrome-nickel steel is employed for the gears, which are fully inclosed in the lower head of

the machine and are mounted on roller bearings. Annular bearings are used on both ends of the armature shaft and a ball thrust bearing takes care of the spindle thrust.

The machine is a late product of the Cincinnati Electrical Tool Co., Cincinnati, Ohio, who manufacture a line of portable electrical drills from ¼ inch to 1¼ inches capacity in steel; weight from 7 pounds up. Power can be tapped from any incandescent lamp socket.

TRADE NOTICES

The Link-Belt Co., of Chicago, Indianapolis, and Philadelphia, announces the following items of interest:

The Round Up Coal Co., of Round Up, Mont., has placed an order for a $25,000 tipple and screening equipment. The Link-Belt Co. are the designers and manufacturers. The Woodward Iron Co. has placed an order for a duplication of their coal washery at Woodward, Ala. This includes duplicate orders for the new Wendell centrifugal coal driers and multiple-compartment jigs. The Phelps Dodge Co. has purchased similar coal-washing equipment for the Stag Cañon Fuel Co., at Dawson, N. Mex.

The Westinghouse Electric & Mfg. Co. announces the following sales:

A contract with the Stonega Coal and Coke Co., of Big Stone Gap, for: Twenty-four 150-kilowatt rotary converters, six-phase, 60-cycle, 275-volt, direct-current 1,200 revolutions per minute; nine 300-kva. single-phase, 60-cycle, 33,000—2,200-volt transformers; seventy-four 50-kva. transformers, single-phase, 60-cycle, 2,200 volts to rotary voltage; six 200-kva. single-phase, 60-cycle, 33,000—2,200-volt and switchboard; one 6-kilowatt combination trolley and storage battery gathering locomotive equipped with two No. 904 motors and Ironclad Exide batteries.

The Mercer Iron and Coal Co. has placed an order for two 200-kilowatt commutating-pole rotary converters, six-phase, 60-cycle, 275-volt, 1,200 revolutions per minute, with transformers and switchboard.

The New Run Co., of MacDonald, W. Va., has contracted for two 150-kilowatt synchronous motor-generator sets, three-phase, 60-cycle, 2,200-volt, 600 volts direct current, 900 revolutions per minute.

The Westmoreland Coal Co., of Pittsburg, Pa., has contracted for one 600-kva. high-pressure turbo unit.

The Lackawanna Coal and Coke Co., of Wehrum, Pa., has bought one 600-kva. turbine unit.

The Lehigh Coal and Navigation Co., of Lansford, Pa., has purchased one 500-kilowatt commutating-pole and one 300-kilowatt commutating-pole rotary transformer, and switchboard.

The Alabama Fuel and Iron Co., of Birmingham, has placed an order for one 300-horsepower hoist motor and liquid control.

The Clinchfield Coal Corporation, of Dante, Va., has bought a 200-kilowatt synchronous motor-generator set, three-phase, 60-cycle, 6,600 volts.

The Roberts & Schaefer Co., of Chicago, announce the following items of interest:

Harty Coal Co., Mullens, W. Va., has bought a No. 3 Marcus combination screen and picking table, including trip feeders, retarding conveyer, etc., all to be installed in connection with a new three-track wooden tipple.

Ayrshire Coal Co., Oakland City, Ind., has purchased a small Stewart coal washery complete with washed coal storage bins, etc.

Lorain Coal and Dock Co., Columbus, Ohio, has completed plans for their new mines at Craneco, W. Va., consisting of four-track steel tipple, including No. 4 Marcus combination screen and picking table and three "RandS" patent loading booms for lump, egg, and nut coal; also 400-foot retarding conveyer, complete with head-house, including dumping and feeding equipment. Entire plant will be built for 400 tons per hour capacity.

Cottonwood Coal Co., Stockett, Mont., has purchased a new plant for Lehigh, Mont., mines, including steel tipple, complete with screens, picking tables, etc., for 3,500 tons per day capacity, and also a reinforced concrete and steel Stewart coal washery with a capacity of 2,000 tons per day, and including mechanical dryer for the washed coal.

The Oregon–Washington Railroad and Navigation Co., Seattle, Wash., has contracted for a 150-ton reinforced-concrete coaling station to be located at Spokane, Wash. This is a two-track station, automatic electric operation, and including sanding facilities.

The Oliphant-Wasson Coal Co., Vincennes, Ind., has contracted for steel tipple for their new mine at Bruceville, Ind., built for duplicate equipment, consisting of two No. 3 Marcus combination screen and picking tables for carrying slack coal from Marcus screens to boiler house.

The Carter Coal Co., Coalwood, W. Va., has contracted for five-track steel tipple for new shaft mine for 700 tons per hour capacity, including two No. 4 Marcus combination picking table screens, three "RandS" patent loading booms for egg, lump, and nut coal, etc.

The Elkins Coal and Coke Co., Morgantown, W. Va. (J. B. Hanford, general superintendent), has contracted for the designing and building of a "Marcus" patent coal tipple with screening and picking facilities, electrically operated and equipped with "RandS" patent shaking loading booms, for installation at Bretz, W. Va.

The Kanawha Mine Car Co., of Charleston, W. Va., announces the changing of its name to Kanawha Mfg. Co.

Armored Wire Rope.—The tensile strength of wire rope of standard construction begins to decrease immediately it is put into service and frequently is quite rapid.

Waterbury Armored Rope (Gore Patent) made by the Waterbury Company, 80 South Street, New York City, embodies the first radical and important improvement in wire-rope construction in many years. Each strand of the rope is wound with

flat steel wire having convex edges and this forms a protective armor which relieves the tensile strength of all abrasive wear and retains intact the strength of the rope until after these flat wires have been worn completely through.

It is claimed that the life of this armored rope is from two to three times that of similar quality rope of standard construction.

The detail of Waterbury armored rope construction which makes it a practical rope for hoisting and haulage is the convex edges of the armor wires. These convex edges permit the flexing of the rope without any creeping of the armor wires.

For severe usage in hoisting and haulage equipments, dredging, steam-shovel service, and other general uses, it is far superior to the ordinary rope of bare-wire construction.

Sanford-Day Iron Works.—An unusually comprehensive catalog of mine wheels, trucks, cars, and equipment has just been published by the Sanford-Day Iron Works, of Knoxville, Tenn. How high efficiency is attained under the many varying mining conditions is given special attention, and every principle of the "Whitney Wonder" wheel is explained in detail.

Increased Use of Coke in Germany

Since the beginning of the war the increased importance of the by-products of the coke oven and gas works in Germany has led to efforts to increase the use of coke by concerns that heretofore have used only coal. The government has begun by mixing certain portions of coke for use on its railways, and in its buildings, and the manufacturers are following this example. The coke ovens and gas works are now depended on to furnish three vitally important products: explosive material, motor fuel, and nitrogenous fertilizer. It is deemed imperative that the production of these by-products be stimulated by the increased demand for coke.—*U. S. Commerce Report.*

THE MEN AT THE FRONT

Men Whose Help You Need in the Buying and Installing of Equipment. Where They Are and What They Do

E. A. Hitchner, who serves coal mining men with equipment made by the Westinghouse Electric and Mfg. Co. has made his headquarters at 27 Sheldon Street, Wilkes-Barre, Pa. Mr. Hitchner formerly had his headquarters in Philadelphia, Pa.

Charles L. Miller, late of the Webster Mfg. Co., Charleston, W. Va. office, and previously associated with the Jeffrey Mfg. Co., is now chief engineer of the Scottdale Machine and Mfg. Co., Scottdale, Pa.

Philip N. Case, sales engineer for the Hyatt Roller Bearing Co., has been placed in charge of all mine-car applications in Ohio, West Virginia, and the western part of Pennsylvania.

Mr. Gleisen, who formerly represented the Hyatt Roller Bearing Co. in western Pennsylvania, Ohio, and West Virginia, will travel in the eastern part of Pennsylvania, New York, and New Jersey.

Frank E. Getts, formerly district sales manager of the Alberger Pump and Condenser Co., Chicago, is now general manager of the Electrical Engineers Equipment Co.

E. W. Swartwont, formerly of the Nordberg Mfg. Co., Chicago office, has become associated with Mr. MacFaren, in the New York office of the company. Enlarged offices have been taken in the new Equitable Building, 120 Broadway, New York. John E. Lord has taken charge of the Chicago office.

H. T. McCaig, representing the Stromberg-Carlson Telephone Mfg. Co., in Iowa, has installed complete mine telephone equipment with the Gibson Coal Mining Co., of Des Moines.

The following appointments and changes have recently been made by the Terry Steam Turbine Co., of Hartford, Conn.: A. W. de Revere has been made district sales manager in Chicago, and the offices have been removed from the Peoples Gas Building to 524 Monadnock Block.

Merton A. Pocock is now district sales manager in the states of Minnesota, North Dakota, and South Dakota. His office is at 400 Endicott Building, St. Paul. This supersedes a previous selling arrangement with Robinson, Cary & Sands Co., of St. Paul.

Joseph Battles is district sales manager at Denver, covering New Mexico, Colorado, Wyoming, and the western part of Nebraska. Headquarters at 326 First National Bank Building, Denver, Colo.

The Hawkins-Hamilton Co., Inc., of Lynchburg, Va., which sells a complete line of power plant and other mechanical equipment throughout Virginia and North Carolina, has recently become the representative for the Terry Steam Turbine Co. in the state of Virginia.

Wm. G. Cummings has taken charge of the Kerr Turbine Co.'s business in West Virginia, with headquarters at 2201 Oliver Building, Pittsburg, Pa. He will give particular attention to exhaust-steam turbine installations. Mr. Cummings was formerly general manager of the Stone Fort Power Co., of Tennessee, operating waterworks and light plants.

Neil H. Brown, formerly Chicago representative for the Bury Compressor Co., of Erie, Pa., has recently been made sales engineer of the Erie Pump and Equipment Co. in northwestern Pennsylvania and western New York.

O. C. Mueller has taken charge of the southern Ohio territory for the B. F. Goodrich Rubber Co., succeeding Mr. Murray. Mr. Mueller specializes on conveyer and elevator belt practices and installations.

The Southwark Foundry and Machine Co. has procured the services of Stewart M. Marshall as manager of its Turbine and Centrifugal Pump Department. All engineering matters relating to apparatus used in conjunction with turbines will also be supervised by him.

For many years Mr. Marshall was chief engineer of the Cambria Steel Co. and later chief engineer of the Conemaugh Smokeless Coal Co., Johnstown, Pa. He is familiar with most of the large steel plants and has a broad knowledge of the best practices in coal mining, by-product coke manufacturing, steel plant operation, power plants, and water supply.

Forms for Concrete Shaft Lining

The form illustrated in Fig. 1 is used by the Clearfield Bituminous Coal Corporation for lining shafts with concrete. The construction is shown plainly by the illustration. The form is placed in position braced, and the concrete poured in behind it. As soon as the concrete is set the form can be removed. The construction makes this a very simple matter as the piece marked *a* is swung inward at the center joint. This releases *b*, *c*, and *d*.

The forms are thoroughly greased before use. In the particular case Keystone grease was used. This might seem to be very expensive but the forms had been used for one shaft and were in condition to be used again, with only one greasing. The use of such a form allows the concrete to be put in as rapidly as it will set and, if smooth boards are used for covering, it gives a very neatly finished wall. In the cases seen the wall was almost as smooth as if it had been given a trowel finish.

A second great advantage is the fact that the same forms can be used repeatedly and there is no loss of lumber, so that this form not only does good work but is economical.

Forms of the same construction are used for lining the shaft during

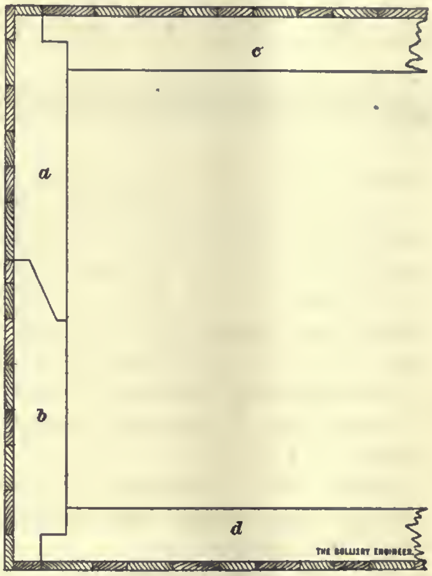

FIG. 1. PLAN OF FORM

sinking and are left in place until the concrete is put in. Then the lower form is removed, the concrete poured, the next form removed and so on.

CATALOGS RECEIVED

WATERBURY COMPANY, 80 South Street, New York, N. Y. Waterbury Armored Rope (Gore Patent) for long, hard service, 32 pages. Waterbury Fibreclad Wire Rope, 23 pages.

INGERSOLL-RAND CO., 11 Broadway, New York, N. Y. "Ingersoll-Rogler Class Fr-1" Steam-Driven Single-Stage Straight-Line Air Compressors, 24 pages. Leyner-Ingersoll Water Drill, Type No. 26, 4 pages.

COMBUSTION ENGINEERING CORPORATION, New York, N.Y. Bulletin B2 Type "E" Stoker, 20 pages.

SULLIVAN MACHINERY CO., 122 South Michigan Avenue, Chicago, Ill. Sullivan Air-Feed Stoping Drills, 12 pages. Sullivan Air Compressors, 32 pages.

KERR TURBINE CO., Wellsville, N. Y. Economy Exhaust Steam Turbines, 14 pages.

LINK-BELT CO., Chicago, Ill. The Circular Storage System, Bulletin No. 221, 4 pages. Wagon and Truck Loaders, 48 pages.

CHICAGO PNEUMATIC TOOL CO., Fisher Building, Chicago, Ill. Instructions for Installing and Operating "Chicago Pneumatic," Class N-SO Fuel Oil Driven Compressors, 24 pages.

JEFFREY MFG. CO., Columbus, Ohio, Wagon and Truck Loaders, Bulletin No. 166, 24 pages. Wagon and Truck Loader, Bulletin No. 165, 16 pages.

BOHANNON-DUGGER EASER JOINT CO., Ensley, Ala., Perfection Excavating Rails, Circular, Easer Joints, 16 pages.

DETROIT TWIST DRILL CO., 634-646 Fort Street, West, Detroit, Mich., The New "Detroit" Quick-Twist Drill, 37 pages.

ALEXANDER MILBURN CO., Baltimore, Md. The Milburn Carbide Miner's Lamp, Circular. The Milburn Oxy-Acetylene Welding and Cutting Apparatus, 32 pages. Milburn Oxy-Acetylene Welding and Cutting Torches, 4 pages. Milburn Portable Acetylene Lights, 48 pages.

KNOX MOTORS CO., Springfield, Mass. The Knox Tractor, 16 pages.

SANFORD-DAY IRON WORKS, Knoxville, Tenn. Mine Wheels, Mine Trucks, Mine Cars, and Equipments, Catalog No. 25.

NATIONAL TRANSIT CO., Oil City, Pa., Bulletin No. 404, Gas Engines, Horizontal Tandem Four-Cycle Double-Acting, 16 pages. Bulletin No. 2-A, Foam Pumps, Fire Protection, Twin Duplex Piston Pumps, 4 pages. Bulletin No. 5, Tools for Pipe Line Construction, 4 pages. Bulletin No. 10, Individual Well Pumping Rig, 4 pages. Bulletin No. 102, Steam Pumps Duplex Direct Acting Klein Piston Type, 8 pages. Bulletin No. 103, Steam Pumps Duplex Direct Acting Packed Piston Separate Chest Type, page 8.

OHIO BRASS CO., Mansfield, Ohio. O-B Overhead Materials, circular.

ASBESTOS PROTECTED METAL CO., Pittsburg, Pa. Asbestos Protected Metal for Roofing and Siding, 62 pages.

Answers to Examination Questions

Questions Asked at Examinations for Mine Foreman Held in Scranton, Pa., May 18 and 19, 1915

Ques. 1.—An airway is 5 feet wide at the top, 10 feet wide at the bottom, and is 6 feet high; if the anemometer reads 280, what is the quantity of air passing?

Ans.—The average width of the airway is $(5+10) \div 2 = 7.5$ feet, and its area is $7.5 \times 6 = 45$ square feet. Assuming that the figures registered on the dial of the anemometer are correct, that is, that no correction must be made to allow for friction, etc., in the anemometer, the quantity of air passing is $45 \times 280 = 12{,}600$ cubic feet per minute.

Ques. 2.—If you suddenly found yourself in an explosive mixture of air and gas, state briefly what you would do.

Ans.—Remove the lamp from the body of gas steadily and quickly, and not in a jerky manner, or it may pass the flame to the outside. If the lamp is flaming, place it under the coat. Then get out of the place, disturbing the air as little as possible while so doing.

Ques. 3.—If 50 revolutions of the fan give 4 pounds pressure, what will the fan give if increased to 70 revolutions?

Ans.—Theoretically, the pressure varies as the square of the quantity of air in circulation, and the quantity varies as the speed of the fan. On this basis, the pressure would be found from the proportion, $50^2 : 70^2 = 4 : x$, whence $x = 7.84$ pounds per square foot at 70 revolutions per minute.

But it is found in practice that the pressure varies about as the fifth root of the eighth power of the speed. Now the ratio of the two speeds is $70 \div 50 = 1.4$, and $\sqrt[5]{1.4^8} = 1.713$; hence, at 70 revolutions per minute the pressure is 1.713 times greater than at 50 revolutions per minute and is $4 \times 1.713 = 6.852$ pounds per square foot. High powers or roots, such as these, cannot be satisfactorily calculated without a knowledge of the use of logarithms.

Ques. 4.—If 9 cubic feet of gas be exploded, how many cubic feet of flame will it make?

Ans.—If it be assumed that the gas and air exist at the most explosive point (9.46 per cent. of methane in air), the mixture will occupy a volume of $9 \div .0946 = 95.14$ cubic feet, and the flame of the explosion, which must of necessity travel completely through the mixture, will have the same volume.

It may further be assumed that the combustion products will be expanded by the intense heat of the explosion and that the flame will travel through this enlarged mass of gas. The heat of explosion will be in the neighborhood of 4,300 degrees, and as the increased volume is proportional to the absolute temperatures before and after the explosion, the expanded volume will be

$$95.14 \times \frac{4{,}300 + 460}{460} = 95.14 \times 10.78$$

$= 1.026$ cubic feet, very nearly. But this temperature is not realized in mine explosions, and further, the gas is not free to expand as it is confined by the ribs, roof, and floor of the gangway. It may be said, then, that the volume of the flame will hardly be less than 95 cubic feet and may be as great as 1,026 cubic feet, although this is highly improbable.

Ques. 5.—How would you proceed to remove a body of firedamp from face of a chamber 40 feet wide, vein 2 feet high?

Ans.—This may be done in various ways, but the usual method would be to conduct a current of intake air to the face, for this purpose building a brattice along one rib. As the chamber is very wide it might be well to build a stopping across its mouth and a second brattice up along the opposite side of the room behind which the return air would pass to the airway; by so doing, to reach the return, the air would have to sweep across the face. If compressed air is used in the mine, a current of it could be forced into the room intake, and this would hasten the removal of the firedamp. The work should be done by the light of electric lamps or, if these are not in use, standard working safety lamps may be employed.

Ques. 6.—If you failed to bar or blast down suspicious roof, would you stand one or two props? Why? What is a guard prop?

Ans.—It would seem the best practice to continue working at the loose rock until it was forced down rather than to resort to propping. However, if it is not possible to dislodge the loose roof, whether one or two props (or even more) should be stood depends upon the thickness and other dimensions of the slate; which the question does not give.

A guard prop is a temporary post used to support the roof while the miner is working at the face, and is set as a matter of precaution and not necessarily because the roof is known to be loose.

Ques. 7.—If you have a 4-inch water gauge, what is the pressure?

Ans.—Since 1 inch of water gauge is due to a pressure of 5.2 pounds per square foot, 4 inches of water gauge represents a pressure of $4 \times 5.2 = 20.8$ pounds per square foot.

Ques. 8.—What should be thought, talked, boosted, and practiced?

Ans.—Every employe should keep in mind that he should take no step in connection with his work nor do any other thing without first seeing to it that his actions will in no way endanger his own life or limb, or those of his fellow workmen; in other words, safety should be the first consideration.

Ques. 9.—(*a*) Do you believe in systematic timbering? (*b*) Who is the best judge of the need of timbering, the boss or the miner? (*c*) How often should the roof be examined?

Ans.—(*a*) I believe in systematic timbering in those mines where the roof is as apt to fall in one part of the chamber as another and where the weak places cannot be detected either by sight or sound. In those mines, however, where the weak spots can be detected, these should be made safe by taking down the loose rock or, if this is not possible, by securely propping the dangerous place.

(*b*) If the miner and the boss are of equal intelligence, the former is the better judge of when and where timbering is needed, as he is constantly in his place. On the other hand, there are many ignorant miners apparently incapable of learning how to care for their places whose judgment as to the need of timbering is not to be relied upon; in such cases, the foreman must decide.

(*c*) How often the roof should be examined depends upon its nature, etc. As a general rule, it should be examined before going to work in the morning, upon returning at noon or after any considerable absence, and after firing a shot. If pillars are being drawn in the neighborhood so that weight is coming on the place, if the roof cuts when freshly exposed to the air, or if it has been jarred by heavy blasting in the next place, etc., more frequent examinations will be necessary than would otherwise be the case.

Ques. 10.—How would you prevent so many men from falling into shafts?

Ans.—The question is not quite clear, and is taken to refer only to accidents due to men at the surface walking into unprotected shaft mouths, and not to accidents due to defective cages or ropes. Shaft accidents of the first kind may be entirely done away with if the shaft is surrounded with a fence, or railing, so constructed that men cannot climb over, under or through it, and if there are a sufficient number of topmen on duty at all times to prevent any one opening the gates. The gates, of which there will be two or four depending upon whether caging is done from one or both sides of the shaft, should be of the type that can only be opened after the cage is at rest on the chairs at the top of the shaft and which must be closed before the chairs can be released so that the cage can descend.

Ques. 11.—What is the area of a right triangle whose base is 15 feet and perpendicular 10 feet?

Ans.—The area of a triangle is equal to one-half of the product of the base and the perpendicular which is otherwise called the altitude. In the question, Area $= \frac{1}{2} \times (15 \times 10) = 75$ square feet.

Ques. 12.—How would you guard against the misuse of electricity in a gaseous mine?

Ans.—It does not seem to us that the answer to this question hinges upon the proper or wrongful use of electricity, but upon whether it may be used at all under conditions which are not very clearly stated, as the term gaseous is a relative one. As long as the percentage of gas in the air is kept below that at which it can be ignited by an electric arc due to short-circuiting a current of the strength used in the mine, the precautions to be observed in the use of electricity are those necessary to prevent men or inflammable material coming in contact with live wires. On the other hand, if the mine is subject to outbursts of gas that cannot be controlled, and if such outbursts are of sufficient magnitude to raise the content of methane to the burning or exploding point, and if they are as liable to occur in one part of the mine as another, then the use of electricity is not allowable in any part of such a mine except in small, low-voltage, storage batteries supplying current to electric hat lamps. Under ordinary conditions the ventilation is such that electric haulage is permissible on the main intake and most of its primary splits; non-sparking gas-proof motors may be used for running small pumps and inside hoists if the places where they are used are ventilated by separate splits of fresh air, but current should not generally be carried into the chambers, as it is not usually possible to ventilate them as well as the gangways.

Ques. 13.—How should a miner take care of his laborer?

Ans.—The miner can best protect his laborer by painstakingly instructing him in his duties and by seeing that all parts of the chamber are safe before he goes to work and are kept so while he is on duty.

Ques. 14.—An accident in hoisting shaft causes the partition between intake and return to be broken; the mine is very gaseous, what would you do? State briefly.

Ans.—This is evidently a catch question as the same shaft, divided into two parts by an air-tight (?) partition, is never used for both intake and return except while sinking and then there is, of course, no mine connected with it. As the conditions are impossible, there is no answer.

Ques. 15.—What quantity of air is traveling through a gangway 12 feet wide and $7\frac{1}{2}$ feet high, when the anemometer registers 472?

Ans.—The area of this airway is $12 \times 7.5 = 90$ square feet. If it be assumed that the anemometer is exact and no corrections need be ap-

plied to its readings and that 472 represents the velocity of the air in feet per minute, then the quantity of air in circulation will be $472 \times 90 = 42,480$ cubic feet.

Ques. 16.—How would you treat a person suffering from shock?

Ans.—As the appliances for treatment for shock are not usually to be had underground, the patient should be wrapped warmly in whatever material is available and taken to the surface. This should not be done, however, until the first-aid treatment for bleeding (if this is taking place) has been made. At the surface place the patient on his back with his head low. If the patient is able to swallow, give him stimulants of some kind such as hot coffee or tea or half a teaspoonful of aromatic spirits of ammonia in a tablespoonful of water. Do not give whiskey if any of the foregoing are to be had; if whiskey must be used, give one large drink. Do not take off the patient's clothes if it can be avoided, but cover him with blankets, coats, and the like. Apply heat to the abdomen and the chest by means of hot water bottles, hot bricks, by towels dipped in hot water and wrung out, or other available means. The arms and legs may be rubbed upwards if it is possible to do so without uncovering the patient. Do not apply heat to the head.

Ques. 17.—What are the three greatest causes of accidents in anthracite mines? Give the percentages of each. How would you reduce these accidents?

Ans.—For a number of years past the principal causes of accident have been, in the order named, falls of roof or coal, mine cars, and improper handling of explosives.

The percentage of accidents due to each of these causes varies from year to year, but those due to falls of roof and coal are about 45 per cent. of the total number of accidents; those due to mine cars, about 15 per cent.; and those due to misuse of explosives, about 12.5 per cent.

As to their origin, accidents may be divided into those which are avoidable and those which are unavoidable. The first class are caused by carelessness or indifference, neglect of orders, etc., on the part of the victim or some one working with him; and some are due to ignorance. It has been shown that, for the anthracite mines, carelessness and disobedience of orders are responsible for 2 out of every 3 fatalities from roof falls; for 7 out every 10 accidents due to mine cars; and for 8 out of every 10 accidents due to handling explosives. The number of accidents due to ignorance may be diminished by personal instruction given to the men at the face, by attendance at night school, by placing the incompetent with the competent until the former have learned their duties, etc. All these methods have been tried and are being tried with considerable success. But it does not seem possible to reduce the terrible number of accidents due to carelessness and disobedience of positive orders and regulations. It is not possible to have a foreman over every worker to see that he does not do the things that his own intelligence tells him are dangerous. Just so long as men lightly value their own lives and those of their fellow workmen, just so long will the list of avoidable accidents be as great as now. At present, the mine foreman can do little but argue, or discharge a man caught violating the law or rules. An arrest might be made, but it is very difficult to secure a conviction.

Of the deaths due to roof falls, some 30 per cent. are classed as unavoidable, which merely means that they are not due to the carelessness of the victims. In some instances they are due to the mine foreman setting men to work in places which have not been made safe, to the failure to provide suitable timber, to poor systems of timbering, but there are always some accidents that could not have been foreseen and, hence, are really unavoidable. Where favorable, a uniform system of timbering will go a long way toward diminishing the number of so-called unavoidable accidents due to roof falls and will materially reduce the avoidable accidents due to the same cause. In addition, during times of pillar drawing, the approach of a squeeze, etc., more frequent visits should be made by the foreman or pillar boss to the working places, that the men may have the benefit of his greater experience.

Of the deaths from car accidents, the 30 per cent. that are classed as unavoidable may be largely reduced if the men are compelled to walk to and from their work on traveling ways separate from the haulage roads. These traveling ways should be kept in the best condition and should be securely timbered, well ditched, cleaned, and drained. If traveling on the haulage roads is unavoidable these should have at least 2½ feet clearance between the car and the rib and should be provided with safety holes in the rib at regular intervals, which should be kept whitewashed and clear of rubbish.

Of the deaths from handling explosives, the 20 per cent. which are classed as unavoidable may be reduced by the use of first-class brands of powder or high explosives, charged and fired in properly placed holes, with detonators of the proper strength, and preferably by electricity applied from a distance, and by the introduction of proper devices for thawing frozen dynamite. It is unfortunate that the employment of skilled shot firers to do all the blasting does not, at present, seem possible in the anthracite regions.

Loss by Soot

So far as the coal consumer is concerned, under the worst circumstances imaginable he could not lose more than 20 pounds of coal per ton through smoke. The great loss occurs through soot whenever the boiler surfaces become coated and thus prevent the heat reaching the water. In one case the loss due to soot was 13 per cent., or 260 pounds coal per ton.

Electrical Equipment Rules

(Continued from Page 678)

distance apart of hangers must be from five (5) feet to eight (8) feet. 10.

25. For attaching to timbers use barn hangers similar to O. B. Fig. 9959 provided with two holes diametrically opposite, use ½×2½ gimlet point lag screws, drilling holes for same with ⅜ of an inch twist bit. Do not use track spikes or nails for fastening hanger bodies to timbers. Do not use regular expansion bolts nailed to header or cross timber. 15.

26. Frogs must be placed 2½ feet in advance of point of latch, and must be held in horizontal position by properly placing hangers on line and close to frogs. 10.

27. Frogs must be placed at each point where branches leave main trolley, and when properly placed will not necessitate the holding of pole while passing over frog at ordinary speeds. 10.

28. Hand-operated trolley switches and signal lights must be placed where mules will pass under trolley. 10.

29. Trolley wire must be protected at switches, crossings, sidings or at any point where it is necessary for men or mules to cross under the trolley wire. 25.

30. The ends of trolley wire must be securely anchored and thoroughly insulated with turnbuckle and strain insulator similar to Fig. 9995 O. B. Co. Turnbuckle must be fastened to S hook wedged to roof. A three-bolt galvanized clamp should be used for fastening end of wire when wire is bent back on itself through strain insulators. 10.

31. Care must be taken that the trolley wire clears the roof, so that the wheel will not touch roof at any time. 10.

32. Where feeders are used they must be erected the same as main line, and tapped in at intervals of two hundred (200) feet by means of feeder ears. The practice of hooking a jumper around an ordinary hanger will not be permitted. 10.

33. At the end of motor road where machine lines ground to rail or at points where rail circuit returns to plant, use several bonded wires leading to return and bond each individual wire into rail in more than one hole; also provide cross bonds at this point. 10.

34. All track traveled by locomotives must have both rails bonded. Cross bond every fifth rail, making bond of sufficient length that it can be bent down below top of ties for protection. 10.

35. Rails weighing 30 pounds and less must be bonded with 11/16-inch channel pins and 2-0 soft copper wire. 5.

36. All 40-pound track must be bonded with 8-inch concealed bonds of 4-0 capacity. 5.

37. All bond holes must be drilled to exact size. Use soap water for drilling rather than oil. All rust, dirt, oil, or moisture must be removed from sides of holes with ½-inch rat-tail file, before inserting bond terminal. Ends of rails and splice bars must be thoroughly cleaned with wire brush before making splice. 10.

38. Channel pin bonds must be placed on inside of rails, and under the bolt heads, and must be of such a length that when placed there will be no kinks or loops in the bond. 10.

39. When cut-out switches are placed in trolley line, hangers must be placed on either side of cut out to give it support. 10.

40. Bonding tools shall consist of the following articles:

1 drift punch ⅝-inch hole, No. 11380 } O. B. Cat.
1 driving tool 20 wire, No. 11384 } O. B. Cat.
1 hand ratchet square socket, No. 11636 } O. B. Cat.
1 taper punch ⅝-inch, No. 11691 } O. B. Cat.
5 ⅝-inch square shank twist drills } O. B. Cat.
1 bond compressor, No. 5437 } O. B. Cat.
1 3-pound ball-pein hammer
1 ½-inch rat-tail file
1 wrench for fish-plate bolts
1 ⅞-inch chisel
1 old man for holding the ratchet against the rail
1 wire brush No. 5½ Fig. 4131 P. G. & S. Co. cat. page 1197.

5. Total 200.

MINE LIGHTING, ETC.

41. Where it is necessary to wire partings, slopes, curves, stables, pump houses, etc., use weatherproof sockets, No. 12 rubber-covered wire, and No. 4 porcelain knobs. Use leather heads and nails for attaching insulators. 5.

42. Under no conditions will wire be permitted to be hung on nails, wrapped around posts, cap pieces or timber of any kind; but wire must be drawn up snug and taut, placed on insulators spaced not more than 15 feet apart. The wires to be placed 4 inches apart and 1½ inches from surface. 25.

43. No rosettes, snap switches, or ordinary sockets can be used in interior of mine. 5.

44. Ordinarily no switches or fuses will be required, but where a large number of lights are used fuses and switches can be used to advantage. 5.

45. The practice of hooking ends of light wires over power circuits must be discontinued and connections must be made with special clamps such as O. B. No. 11160 current tap, clamped to feeder. 10.

46. Where it is necessary to turn lights on and off frequently in interior of mine, knife switches must be used. 5.

47. Where wire goes through stoppings or partitions in entering stables, pump houses, etc., porcelain tubes must be used. 15.

48. All splices and joints must be electrically and mechanically secure without solder, and then soldered. All joints must have an insulation equal to that of conductor. 10.

49. Care must be taken that all wires are put up in a neat and substantial manner, one wire to an insulator. 10.

50. Tie-wire must be of the same size as wire being hung (No. 12 R. C.) with no less than six turns of wire on each side of insulator. 10. **Total 100.**

The machine boss is responsible for the operation and maintenance of all the machinery in and around the mines. His efficiency and value to the company is estimated by the number of delays to the machinery; the cost of supplies per ton of coal hauled or mined, and by the general appearance and condition of the machinery.

The following rules are laid down for his guidance in properly looking after the equipment under his care:

51. It is the duty of the machine boss to see that all motormen, machine men, and pumpers oil and care for the machines they operate in the best manner possible.

52. Motormen are required to make a daily report on the condition of their locomotives, and the machine boss must go over the reports and see that the repairs are made at once. Bolts, nuts, braces, etc., must be tightened up as soon as they are found to be loose. 15.

LOCOMOTIVES

53. Controllers must be opened and inspected twice each week, or oftener if necessary. 10.

54. Burnt or worn fingers and segments must be replaced at once. Finger screws must be adjusted to allow good contact between fingers and segments and then locked with jamb nuts. 25.

55. The segments should be greased sparingly with vaseline at each inspection. 10.

56. Charred wood is a good conductor of electricity, therefore, burnt or blackened spots on the fingerboards should be scraped clean and then painted with an insulating paint as soon as they develop, otherwise the fingerboard will be rapidly carbonized and destroyed. 10.

57. The interlocking device between controller cylinder and reverse cylinder and the notching pawls on both cylinders must be kept in good order and the locomotive must not be operated without them. 25.

58. Arc deflectors and division plates must be replaced as soon as they are burned out. 10.

59. The front and back of the controller must be lined with ⅛-inch asbestos sheet to prevent gas from the arc reaching the iron, causing a short circuit. 10.

60. The wire between controllers, motors, and resistance must be connected as shown on the manufacturer's blueprint. (Blueprints can be procured by ordering on your regular requisitions.) 20.

61. The controller must be bolted fast to the foot-pan of the locomotive and properly braced to prevent it swinging about. 10.

62. Care should be taken to see that the controller case is thoroughly grounded to the motor frame for the motorman's protection. 5.

63. Extra flexible No. 2 R. C. D. B. cable must be used for all locomotive wiring. The ends of the cable must be well soldered to prevent it from fraying where it enters the terminal holes of resistance, field coils, finger bases and brush holders. 10.

64. If the cable is too large to fit the terminal holes, it should be dipped in solder and then filed to fit the holes, or it may be soldered to reducing nipples provided for the purpose. 5.

65. If the cable is too small for terminal holes it must be wrapped with wire to increase the diameter and then dipped in solder. 5.

66. Controller cables must be neatly secured in a bundle by wrapping with several layers of non-elastic webbing or surgical tape. The tape should be saturated with air-drying paint. 10.

67. The cable tree must be clamped or otherwise supported in such a way as to prevent it from coming in contact with the wheels, gears or brake rigging of the locomotive. 15.

68. The resistance end of controller cables should be protected by asbestos sleeving where they are exposed to extreme heat. 5.

69. Field and brush-holder cables must be fastened in the motor case in such a way as to prevent them from rubbing the armature or commutator and must be brought out of the motor case through holes bushed with wood or rubber, and must not be brought out through commutator hand holes except in an emergency and then it must be changed at the first opportunity. 25.

70. Controller cables should be connected to the field and brush-holder cables with knuckle-joint connectors in order that the joints may be easily broken for removal of armatures and fields. 5.

71. All splices in the cable must be mechanically and electrically secured without solder and then soldered. Splices must be tapped with an insulation equal to the balance of the cable. 5.

72. Resistance frames must be well supported and braced to prevent them from swinging about and coming in contact with the locomotive frame or with one another. 20.

73. Broken girders must be replaced at once. 5.

74. Mud or dirt of any kind must not be allowed to accumulate on or about the resistance. 10.

75. The insulated tie-bolts through the resistance should be tightened occasionally to maintain good contact between the grids. 10.

76. Jumper connections from one resistance frame to another must be insulated with asbestos sleeving. 5.

77. Brakes should be maintained so that it is possible to slide the wheels at all times. It should never be necessary

to resort to "bucking" the motors to hold the trips. 30.

78. Field coils should fit tightly between the pole tips and motor case to prevent them moving with the attendant danger of the insulation becoming chaffed and grounding the cable. If the coils are too loose, they may be tightened by placing liners of oil canvas between them and the frame, or an extra layer of nonelastic webbing can be taped on the coil and then saturated with insulating paint. 35.

79. After replacing defective field coils, they must be tested for polarity before inserting the armature in the case. This may be done by dropping the top half of the casing on the lower half, short circuiting one brush holder on the other, make the usual field connections, then put the controller on the first point and try the attraction between adjacent field tips with a hammer. The pull should be uniform between any two adjacent field tips. 35.

A little experimenting will enable one to detect a reversed field coil in this manner very readily. It is important that the above rule will be followed and no excuse will be accepted for armatures burnt out owing to reversed field coils.

80. Armatures must be placed in the armature case before the pinion is put on the shaft, and turned several times to ascertain that it revolves freely and does not rub the pole tips, field coils or motor case. 25.

81. Brush holders must be adjusted to clear the commutator from 1/8 inch to 3/16 inch and no more. 15.

82. When brushes begin to fire, due to high mica in the commutator, the mica must be slotted at once. 10.

83. A great deal of trouble due to grounded field coils and armatures has been caused by mud and water splashing into the motor cases through the bottom handholes; also numerous armatures have been ruined by pinion teeth, nuts and bolts entering the motor case through the commutator handhole and becoming ground between the armature and pole pieces, therefore, it is important that all hand holes be covered except when the motor is undergoing repairs. 15.

84. Considerable armature trouble has been caused by excess oil from the bearings entering the commutators and windings causing rapid deterioration of the insulation. 20.

In general, cup grease will be found to give the best results on armature bearings if care is taken to push the grease down on the armature shaft once or twice each day. On motors where bearing construction requires a thin oil for lubricant, care should be taken to reduce the amount to a minimum consistent with satisfactory operation of the bearing.

85. Armature bearings must be examined frequently and replaced before there is any danger of the poles being rubbed by the armature. 35.

86. Gear-cases must be kept on all locomotives and must have a quantity of clean oil in them. 10.

87. Sand must not be allowed to enter the gear-cases. 5.

88. Driving wheel tires must be replaced before they are worn more than 5/16 of an inch. 25.

89. Wearing strips between wheels and journal boxes must be replaced when they are worn badly. 5.

90. Journal-box lids must be kept on

to prevent sand and dirt entering the journal bearing. 15.

91. Journal boxes must be packed with clean wool waste saturated with car or other heavy oil, and must be reoiled once each day or oftener if necessary. 10.

92. Axle bearings may be lubricated with cup grease or wool waste saturated with heavy oil. 5.

93. Sanding devices must be kept in good working order on both sides and both ends. 20.

94. Gathering motor reels should be inspected and cared for in the same manner as the other parts of the locomotive. 5.

95. Dirt and grease should be wiped off of the collecting ring insulations occasionally. 5.

96. Number 2 R. C. D. B. extra flexible single conductor cable should be used on 250-volt locomotive gathering reels and No. 4 on 500-volt locomotives.

97. Suspension springs and bars must be maintained in good order to prevent the motors from jumping excessively when starting. 10.

98. All locomotives must be equipped with headlights, which must be maintained in good order at all times. 5.

99. All supplies and tools for locomotives must be kept in one place and in an orderly manner. 15.

100. All unused material must be gathered up and put in its proper place after completing a repair job. 15.

101. Armatures must be kept completely boxed up and in a dry place or else be placed in a rack on the side of the walls where they are not apt to be injured by water or heavy material falling on them. 10.

102. Wire hangers and clamps, pieces of wire, insulators, etc., must not be left lying about the mine. 5. **Total 670.**

PUMPS AND STATIONARY MOTORS

103. Pump and all stationary motors must be equipped with starting boxes of ample capacity unless the motor is built for starting without one, and in no case must motors over 5 horsepower be started without a starting box. 5.

104. Gathering pump motors, which are not of the self-starting type, should be equipped with automatic starting boxes. 5.

105. Water barrel starters must not be used except as emergency device and then only for a very limited time. 5.

106. Starting boxes should be mounted on iron brackets which separate them from the wall not less than six (6) inches. 5.

107. Starting boxes must be attached to supports by bolts or screws so that they can be easily removed. 5.

108. All stationary motors must be protected with switches and enclosed fuses. 10.

109. Pump motors which have one side of circuit grounded to the rail near motor will only require one S. P. switch and one S. P. fuse block in positive line. Motors which have an all-wire circuit will require one S. P. switch and one S. P. fuse block in each line. 5.

110. The fuses must be placed between the switches and the motors so that the fuses can be replaced with safety when the switches are out. 5.

111. No single pole switch of less than 75 amperes capacity can be used. 5.

112. Fuses for motors must be used in accordance with the following table: 10.

Ampere Capacity of Fuse

500-Volt Motors		250-Volt Motors
Horsepower	Horsepower	Horsepower
*5	15	30
7½	20	40
10	25	50
15	35	75
20	50	100
25	60	125
30	75	150
40	100	200
50	125	300

*Five-horsepower self-starting motors, both 250 and 500 volts require 35-ampere fuses.

113. Circuit breakers should be used on motors over 25 horsepower. 5.

114. Pump men and motor operators must be provided with extra fuses, and copper wire must not be substituted for the fuse under any circumstances. 5.

115. Wire between motors and starters and between switches and starters must be run on porcelain knobs in such a way as to prevent it being broken. 5.

116. All motor leads must be soldered into terminal lugs on the motor terminal boards and on switches. 5.

117. Tie-wires must have an insulation equal to that of the conductor. 5.

118. All joints and splices must be electrically and mechanically secure without solder and then soldered. 5.

119. Joints should have an insulation equal to the remainder of the wire. 5.

120. All wires must be insulated where they enter buildings, or pass through walls, with porcelain tube or circular loom. 5.

121. Wires must be soldered to mains and run on insulators at least 4 inches apart and 1¼ inches distant from the surface. 5.

122. Wire between switches and starting boxes and motors should be used in accordance with the following table: 10.

Horsepower of the Motor	Size of Wire B. S. Gauge
5 to 10	10
10 to 20	6
20 to 30	4
30 to 40	2
40 to 60	1

123. The same care should be exercised in changing stationary motor armatures and fields as with locomotives. 20.

124. All stationary motors are oiled automatically with oil rings and it is only necessary to change the oil every few weeks and replenish the supply in the oil well occasionally. 5.

125. Motors should be wiped off regularly and oil must not be allowed to accumulate in the bottom of the field frame. 5.

126. Copper and carbon dust must not be allowed to accumulate on the brush-holder insulation. 15.

127. Stationary motors should operate practically sparkless, when the commutator is properly taken care of. Steps must be taken to locate the trouble when excessive sparking is observed. 5. Total 165.

PUMPS

128. Pumps should be cleaned and inspected regularly. 5.

129. Oil or grease cups should be provided for all bearings and care should be taken to see that they feed properly. 10.

130. Connecting-rods must be keyed up or have liners taken from them when they commence to pound due to worn babbitt or brasses. 10.

131. Plungers must be kept well packed and be lubricated with cup grease or heavy oil. 15.

132. Plunger glands must be pulled up evenly all around when tightening packing and not allowed to bind the plunger on one side or the other. 10.

133. All gears must be lubricated with grease. 5.

134. All gear-covers and guards must be kept in place. 10.

135. Suction pipes must be covered with strainers and be placed in as large a body of water as possible to prevent dirt being drawn into the pump. 10.

136. All gaskets and joints must be kept tight and free from leaks. 5.

137. Gear-wheels must not be allowed to run in mud or water. 5.

138. Packing, valves, springs, brushes, or other supplies must be kept in an orderly manner and must not be left lying about the pump room and floor after making repairs. 10.

139. Old valves and pieces of brass must be taken outside of the mines when they have been discarded. 5. **Total 100.**

MINING MACHINES

140. Mining machines must be inspected frequently.

141. Armature fields must be looked after in the same manner as stationary motors. 5.

142. Oil and dust must be kept from accumulating on brush holders and in the bottom of motor cases. 10.

143. All bearings must be oiled frequently, more especially the cutter head and armature bearings. 10.

144. Starting rheostats must be fastened to the frame of the motor securely. 10.

145. Starting rheostat boards must not be allowed to become charred and burned. 5.

146. Safety washers or lugs must be used on all machines; solid washers will not be permitted. 5.

147. Extra safety washers must be kept on hand at all times. 5.

148. All machines must be provided with fuses of the proper capacity and no other may be used. 5.

149. Machines must not be allowed to operate with dull bits. 5.

150. Field and armature leads must be supported in a neat way and must not be allowed to hang loosely about the motor. Steps must be taken to eliminate flashing at the brushes when it is observed. 5.

Total 65.

C. V. Gould, a mining engineer of Salt Lake City, in the *Salt Lake Review*, says that the 2,000-acre property of the United States Coal Co., at Conroy, Wyo., contains eleven large seams, the aggregate thickness being from 200 to 250 feet and has an estimated tonnage of 500,000,000 tons. The largest seam is 84 feet in thickness, and is clean coal from top to bottom. It is classified as subbituminous by the United States Geological Survey.